CR-128659

Space Shuttle Program

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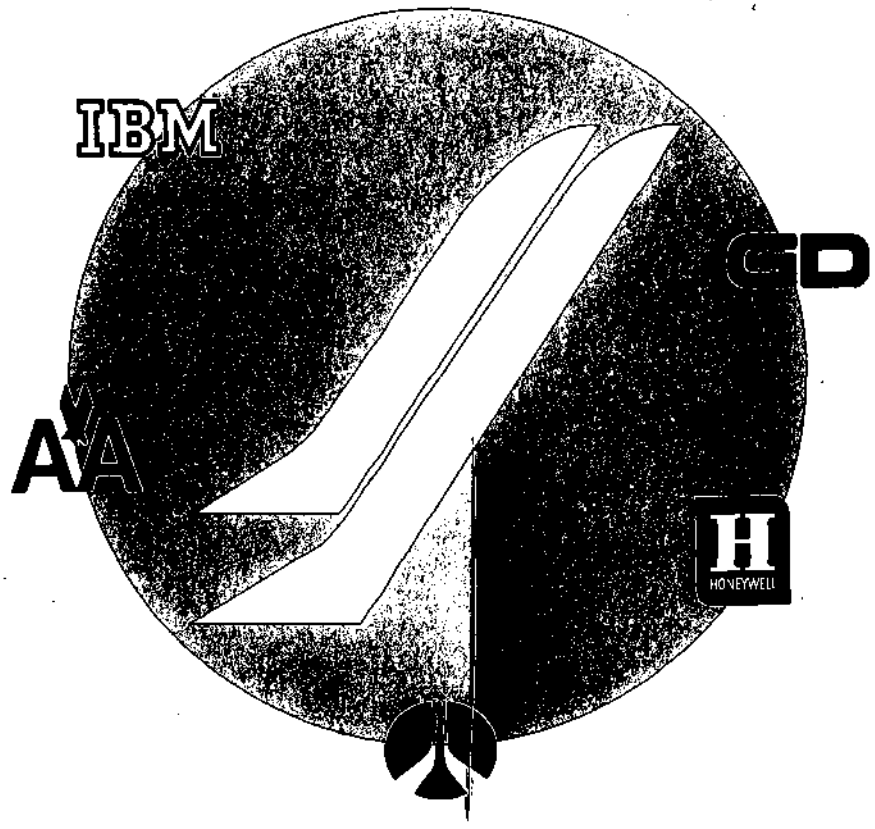
FINAL SUBMITTAL

(NASA-CR-128659) EXPENDABLE SECOND STAGE REUSABLE SPACE SHUTTLE BOOSTER. VOLUME 4: DETAIL MASS PROPERTIES DATA Final Report, Phase B (North American Rockwell Corp.) 25 Jun. 1971 103 p CSCL 22B

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G3/31 50794



Phase B Final Report
Expendable Second Stage
Reusable Space Shuttle Booster
Volume IV. Detail Mass Properties Data

Contract NAS9-10960, Exhibit B
DRL MSFC-DRL-221, DRL Line Item 6
DRD MA-078-U2
SD 71-140-4
25 June 1971

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SD 71-140-4
(MSC-03321)

25 June 1971

PHASE B FINAL REPORT
EXPENDABLE SECOND STAGE
REUSABLE SPACE SHUTTLE BOOSTER

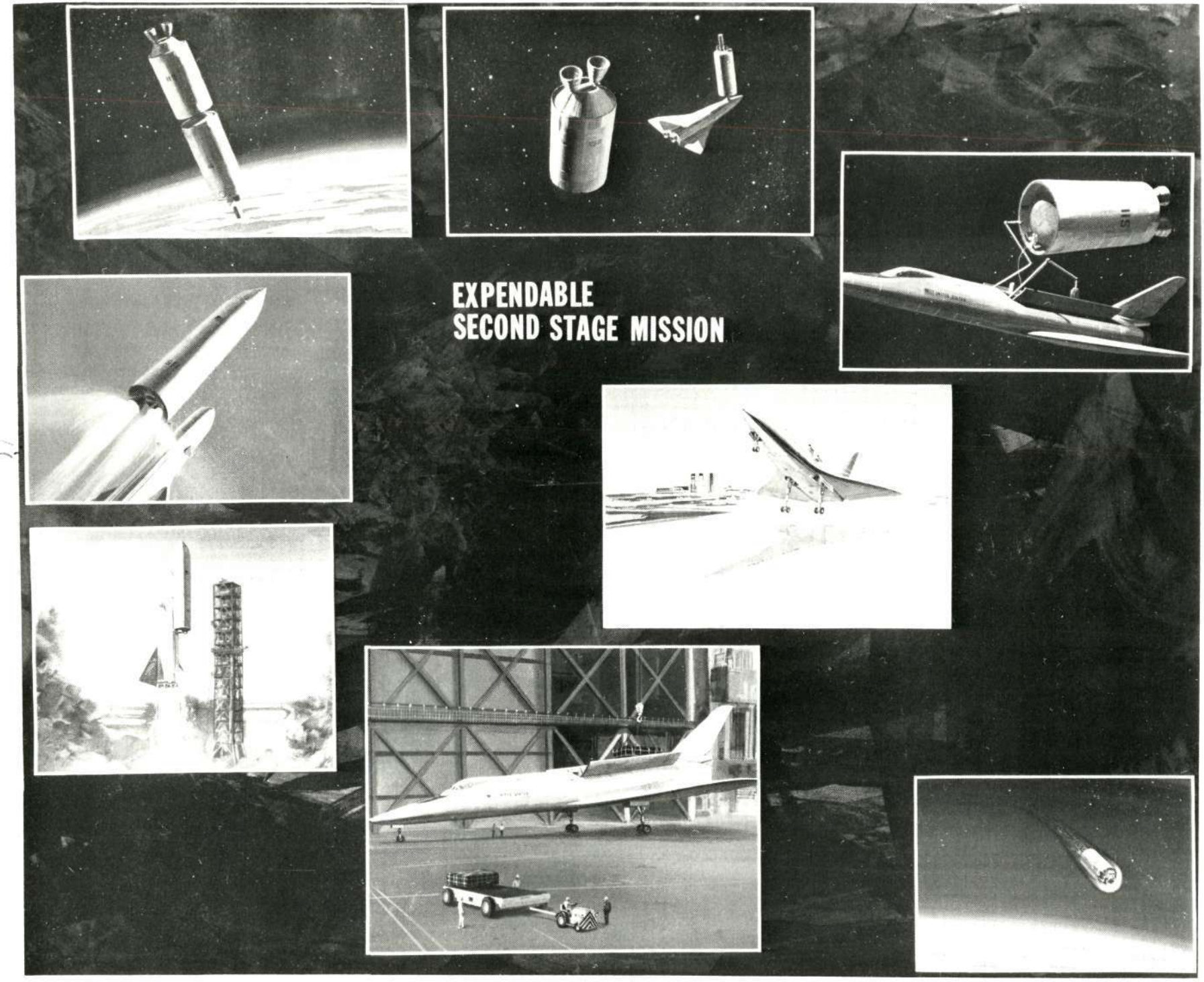
Volume IV
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DRD MA-078-U2

Approved by

for B. Hello
Vice President and General Manager
Space Shuttle Program

Space Division • North American Rockwell 12214 LAKEWOOD BOULEVARD • DOWNEY, CALIFORNIA 90241


EXPENDABLE
SECOND STAGE MISSION



FOREWORD

The Space Shuttle Phase B studies are directed toward the definition of an economical space transportation system. In addition to the missions which can be satisfied with the shuttle payload capability, the National Aeronautics and Space Administration has missions planned that require space vehicles to place payloads in excess of 100,000 pounds in earth orbit. To satisfy this requirement, a cost-effective multimission space shuttle system with large lift capability is needed. Such a system would utilize a reusable shuttle booster and an expendable second stage. The expendable second stage would be complementary to the space shuttle system and impose minimum impact on the reusable booster.

To assist the expendable second stage concept, a two-phase study was authorized by NASA. Phase A efforts, which ended in December 1970, concentrated on performance, configuration, and basic aerodynamic considerations. Basic trade studies were carried out on a relatively large number of configurations. At the conclusion of Phase A, the contractor proposed a single configuration. Phase B commenced on February 1, 1971 (per Technical Directive Number 503) based on the recommended system. Whereas a large number of payload configurations were considered in the initial phase, Phase B was begun with specific emphasis placed on three representative payload configurations. The entire Phase B activity has been directed toward handling the three representative payload configurations in the most acceptable manner. Results of this activity are reported in this 12-volume Phase B final report.

Volume I	Executive Summary	SD 71-140-1
Volume II	Technical Summary	SD 71-140-2
Volume III	Wind Tunnel Test Data	SD 71-140-3
Volume IV	Detail Mass Properties Data	SD 71-140-4
Volume V	Operations and Resources	SD 71-140-5
Volume VI	Interface Control Drawings	SD 71-140-6
Volume VII	Preliminary Design Drawings	SD 71-140-7
Volume VIII	Preliminary CEI Specification - Part 1	SD 71-140-8
Volume IX	Preliminary System Specification	SD 71-140-9
Volume X	Technology Requirements	SD 71-140-10
Volume XI	Cost and Schedule Estimates	SD 71-140-11
Volume XII	Design Data Book	SD 71-140-12

This document is Volume IV, Detail Mass Properties Data.

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1.0 INTRODUCTION

The mass properties herein are presented to describe the final results of the completed Phase B study of an expendable second stage with a reusable booster. The purpose of this volume is to describe the final mass characteristics of the vehicle configurations for the three specified payloads in terms of weight, center of gravity, and mass moments of inertia. Data are presented on an individual basis for each of the following configurations:

B-9U booster + ESS/MDAC space station
B-9U booster + ESS/reusable nuclear stage
B-9U booster + ESS/NR space tug



2.0 REQUIREMENTS AND CRITERIA

This report consists of elements identified in Section IV of the Study Control Document for the study of an expendable second stage (ESS) with a reusable booster. The format designated for mass properties reporting, as utilized for the Space Shuttle Phase B study, is used herein.

The report is divided into three basic sections: the integrated vehicle system, the ESS, and the booster modifications. A fourth section includes the vehicle configurations on which the mass properties are based.

3.0 INTEGRATED VEHICLE SYSTEM

This section includes the mass characteristics of the three combined configurations during the mated portion of their flight operation. Weight data are shown for both the booster and ESS vehicles in a summarized tabulation which gives a "first generation" system breakdown. In order to describe the mass properties of the mated system (B-9U + ESS/Payload), for critical events of powered flight, Sequenced Mass Properties Statements are included. These data present the mass properties of the mated configuration at "liftoff," "Qmax," "max G," and "End Boost." The center of gravity movement resulting from the booster ascent propellant consumption during operation from Liftoff to End Boost is presented graphically. The relative center of gravity ranges anticipated for both the Shuttle and ESS System concepts are shown in a drawing at the end of this section.

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS-MDAC SPACE STATION		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP	61,990							
2.0	TAIL GROUP	19,230							
3.0	BODY GROUP	182,772				57847	42	21	37
4.0	INDUCED ENVIR PROTECT	82,644							
5.0	LANDING, DOCKING	27,361							
6.0	PROPULSION, ASCENT	130,186				25328	90	10	
7.0	PROPULSION, CRUISE	50,413							
8.0	PROPULSION, AUXILIARY	10,557				4710	100		
9.0	PRIME POWER	1,801				3400	100		
10.0	ELECTRICAL CONV & DISTR	1,438				1190	100		
11.0	HYD & PNEU DISTR	1,862				406	10	90	
12.0	SURFACE CONTROLS	7,889							
13.0	AVIONICS	5,468				2955	100		
14.0	ENVIRONMENTAL CONTROL	1,650				1100	100		
15.0	PERSONNEL PROVISION	1,600							
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH	46,486							
19.0	ESS PLATFORM	9,770							
	SUBTOTAL (DRY WT)	643,117				96936	63	15	22
20.0	PERSONNEL	476							
21.0	PAYLOAD					176,960	100		
22.0	ORDNANCE								
23.0	RESIDUAL FLUIDS	11,476				5965	100		
24.0	PAYLOAD MARGIN					5330	100		
	SUBTOTAL (INERT WT)	655,069				285,191	88	5	7
25.0	RESERVE FLUIDS					6659	100		
26.0	INFLIGHT LOSSES	20,802				83	100		
27.0	PROPELLANT-ASCENT	3,382,307				677,150	100		
28.0	PROPELLANT-CRUISE	143,786							
29.0	PROPELLANT-MANEUV/ACS	1,500				22,917	100		
30.0									
	TOTAL (GROSS WT) LB	4203464	100			992,000	98	1	1

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

ORBIT
INCLINATION 55°
ALTITUDE 270 NM

FORM 3945-A-13 NEW 8-70

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS – RNS		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP	61990							
2.0	TAIL GROUP	19230							
3.0	BODY GROUP	182772				54847	42	21	37
4.0	INDUCED ENVIR PROTECT	82644							
5.0	LANDING, DOCKING	27361							
6.0	PROPULSION, ASCENT	130186				25328	90	10	
7.0	PROPULSION, CRUISE	50413							
8.0	PROPULSION, AUXILIARY	10557				4710	100		
9.0	PRIME POWER	1801				3400	100		
10.0	ELECTRICAL CONV & DISTR	1438				1190	100		
11.0	HYD & PNEU DISTR	1862				406	10	90	
12.0	SURFACE CONTROLS	7889							
13.0	AVIONICS	5468				2955	100		
14.0	ENVIRONMENTAL CONTROL	1650				1100	100		
15.0	PERSONNEL PROVISION	1600							
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH	46486							
19.0	ESS PLATFORM	9770							
	SUBTOTAL (DRY WT)	643117				96936	63	15	22
20.0	PERSONNEL	476							
21.0	PAYLOAD					83000	100		
22.0	ORDNANCE								
23.0	RESIDUAL FLUIDS	11476				5965	100		
24.0						9314	100		
	SUBTOTAL (INERT WT)	655069				195215	82	8	10
25.0	RESERVE FLUIDS					10480	100		
26.0	INFLIGHT LOSSES	20802				83	100		
27.0	PROPELLANT-ASCENT	2749260				428198	100		
28.0	PROPELLANT-CRUISE	143786							
29.0	PROPELLANT-MANEUV/ACS	1500				17724	100		
30.0									
	TOTAL (GROSS WT) LB	3570417	100			651700	94	2	4

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

ORBIT

INCLINATION 31.5°
ALTITUDE 260 NM

FORM 3945-A-13 NEW 8-70

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS - NR TUG		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP	61990							
2.0	TAIL GROUP	19230							
3.0	BODY GROUP	182772				57847	42	21	37
4.0	INDUCED ENVIR PROTECT	82644							
5.0	LANDING, DOCKING	27361							
6.0	PROPULSION, ASCENT	130186				25328	90	10	
7.0	PROPULSION, CRUISE	50413							
8.0	PROPULSION, AUXILIARY	10557				4710	100		
9.0	PRIME POWER	1801				3400	100		
10.0	ELECTRICAL CONV & DISTR	1438				1190	100		
11.0	HYD & PNEU DISTR	1862				406	10	90	
12.0	SURFACE CONTROLS	7889							
13.0	AVIONICS	5468				2955	100		
14.0	ENVIRONMENTAL CONTROL	1650				1100	100		
15.0	PERSONNEL PROVISION	1600							
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH	46486							
19.0	ESS PLATFORM	9770							
	SUBTOTAL (DRY WT)	643117				96936	63	15	22
20.0	PERSONNEL	476							
21.0	PAYLOAD					107180	100		
22.0	PAYLOAD ADAPTER					10000	100		
23.0	RESIDUAL FLUIDS	11476				5965	100		
24.0	PAYLOAD MARGIN					9413	100		
	SUBTOTAL (INERT WT)	655069				229494	85	6	9
25.0	RESERVE FLUIDS					18487	100		
26.0	INFLIGHT LOSSES	20802				83	100		
27.0	PROPELLANT-ASCENT	2941395				496420	100		
28.0	PROPELLANT-CRUISE	143786							
29.0	PROPELLANT-MANEUV/ACS	1500				10401	100		
30.0									
	TOTAL (GROSS WT) LB	3762552	100			754885	95	2	3

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

ORBIT

INCLINATION 28.5°
ALTITUDE 100 NM

FORM 3945-A-13 NEW 8-70

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: B-9U BOOSTER + ESS/MDAC SS | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES X	Y	Z	MOMENT OF INERTIA SLUG FT^2 X 10– $I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	PRODUCT OF INERTIA SLUG FT^2 X 10– I_{xy}	I_{xz}	I_{yz}
	Liftoff	5195464	2161	0.0	471.3	50.82	636.74	598.93	0.0	8.30	0.0
	Booster Ascent Prop	-1412842									
	Max q Flight Condition	3782622	2341	0.0	498.0	48.70	493.08	457.41	0.0	-10.12	0.0
	Booster Ascent Prop	-612441									
	Max G Flight Condition	3170181	2427	0.0	516.9	47.18	430.57	396.40	0.0	-19.41	0.0
	Booster Ascent Prop	-1351264									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1813157	2604	0.0	616.8	37.25	273.82	249.57	0.0	-40.76	0.0
	ESS Separation	-992000									
	Booster Vent Residuals	- 17571									
	Booster ACS Prop	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-7.66	0.0

NOTES:

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: B-9U BOOSTER + ESS/RNS | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10–			PRODUCT OF INERTIA SLUG FT^2 X 10–		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
	Liftoff	4222117	2242	0.0	451.4	39.02	563.34	537.14	0.0	-1.18	0.0
	Booster Ascent Prop	-1151550									
	Max q Flight Condition	3070567	2413	0.0	470.8	38.11	446.14	420.85	0.0	-1.30	0.0
	Booster Ascent Prop	-511800									
	Max G Flight Condition	2558767	2503	0.0	485.0	37.5	390.46	365.84	0.0	-25.27	0.0
	Booster Ascent Prop	-1080150									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1472857	2694	0.0	562.9	32.11	257.51	238.20	0.0	-34.03	0.0
	ESS Separation	-651700									
	Booster Vent Residuals	- 17571									
	Booster ACS Prop	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-2.66	0.0

NOTES:

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION
B-9U BOOSTER + ESS/NR TUG

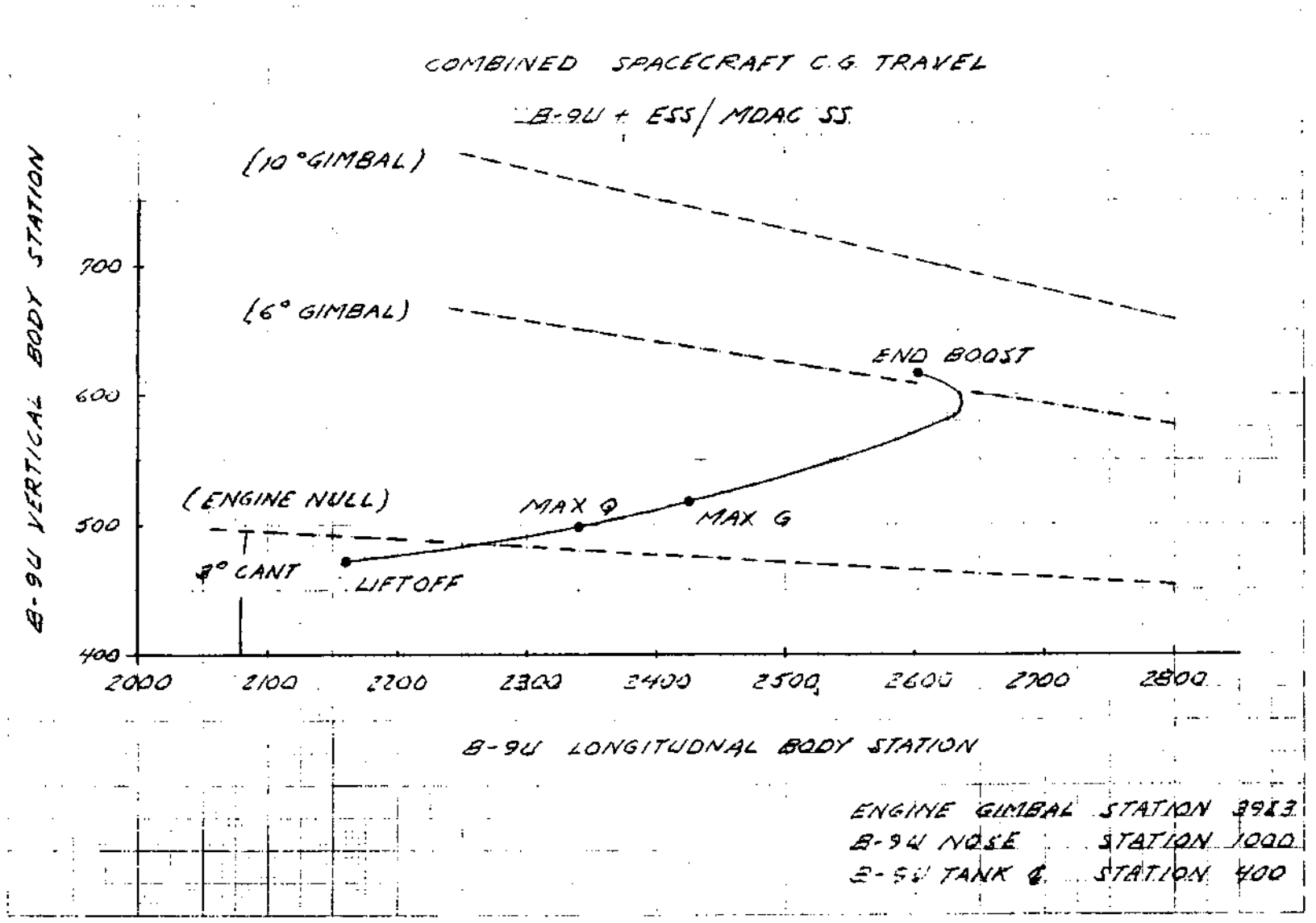
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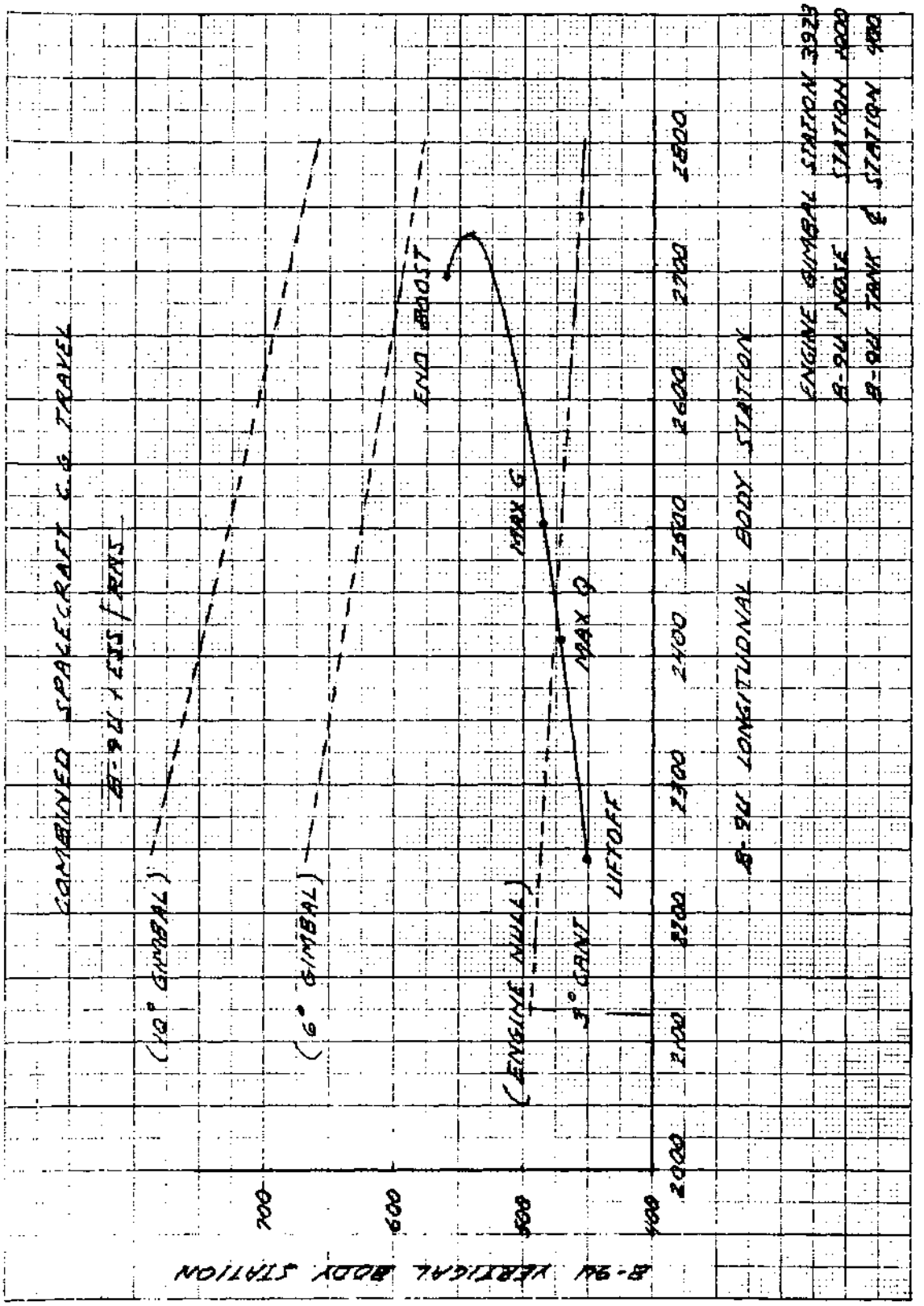
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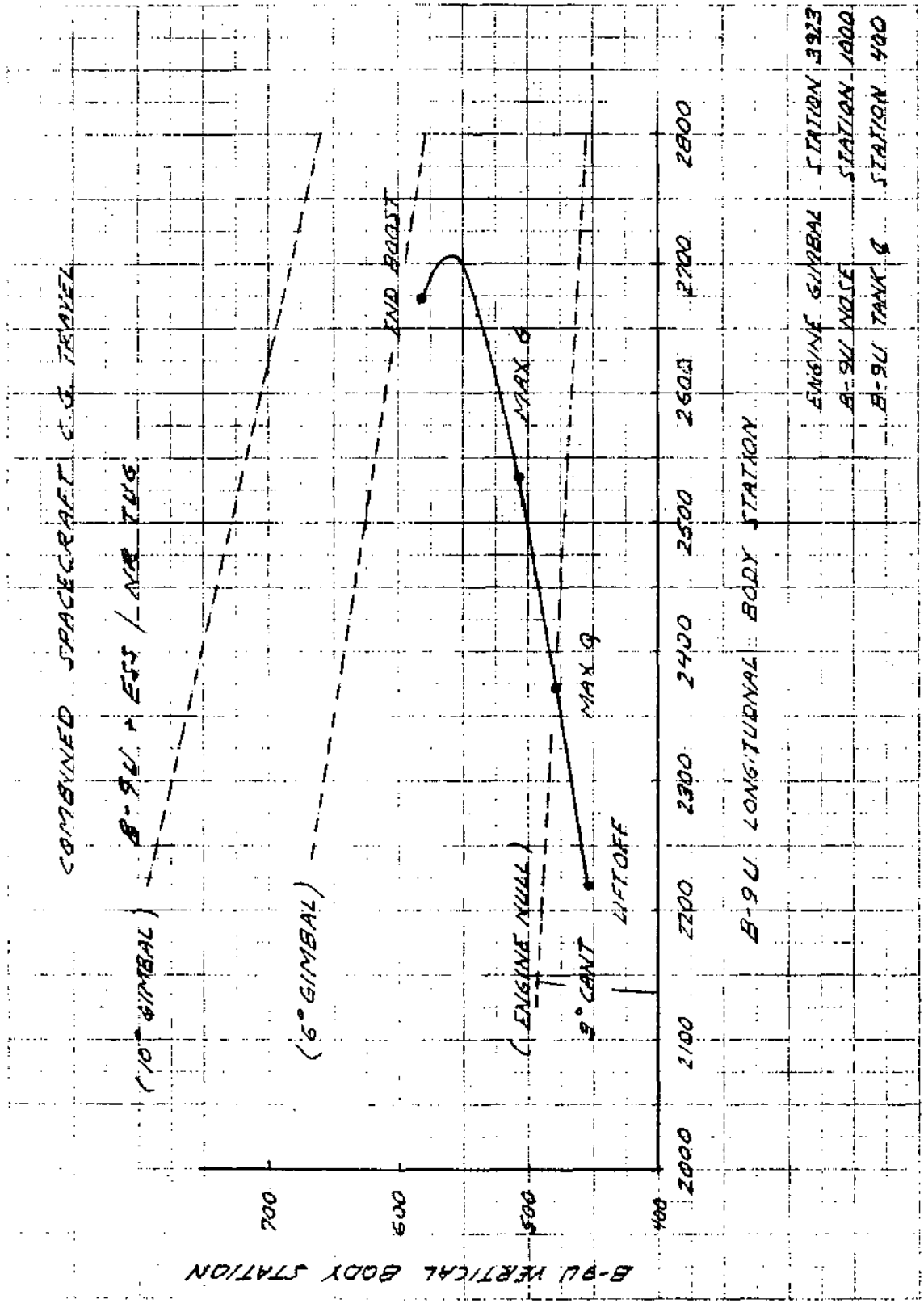
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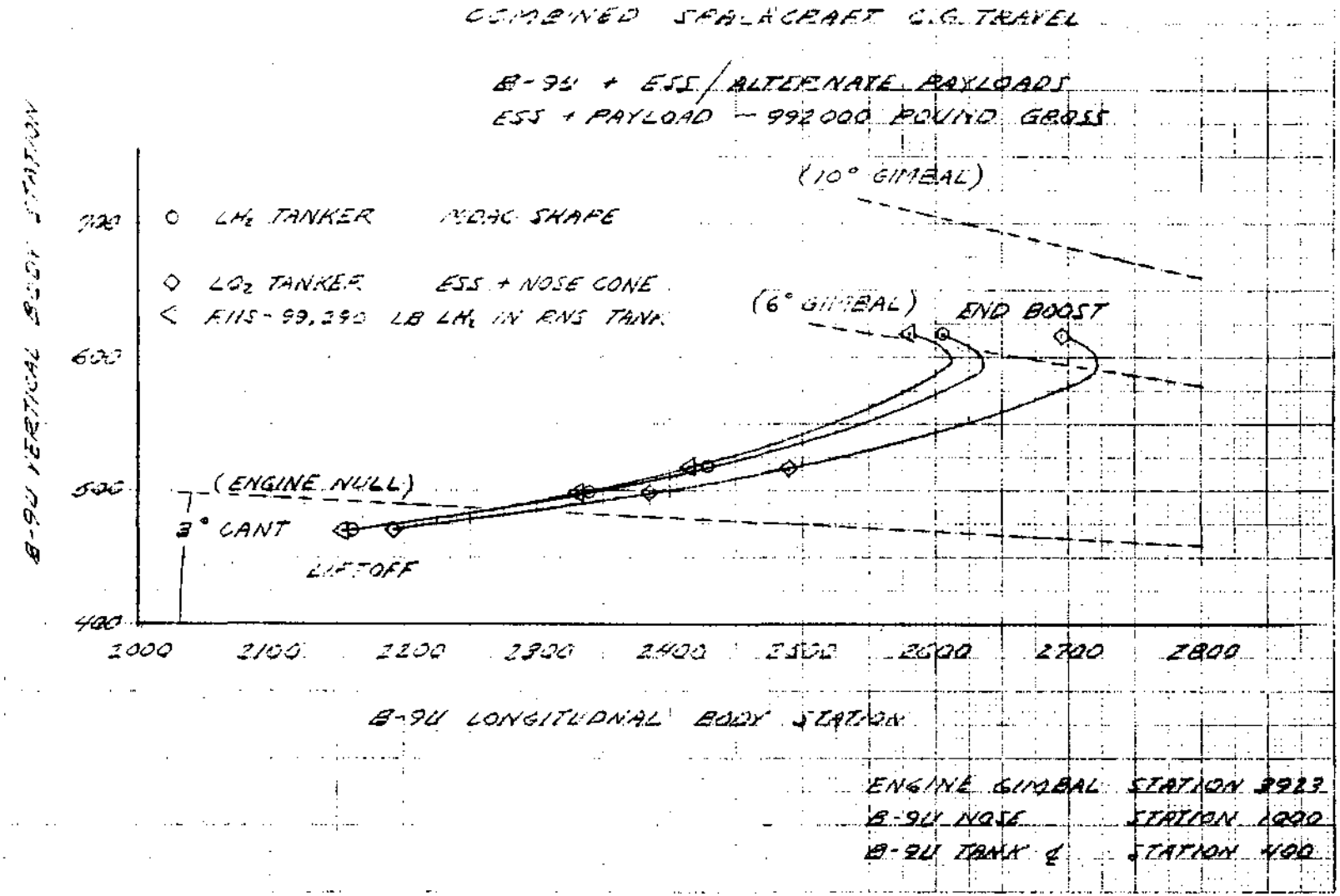
NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10–			PRODUCT OF INERTIA SLUG FT^2 X 10–		
			X	Y	Z	$I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	I_{xy}	I_{xz}	I_{yz}
	Liftoff	4517437	2219	0.0	458.4	41.97	569.71	539.84	0.0	1.80	0.0
	Booster Ascent Prop	-1093026									
	Max q Flight Condition	3424411	2372	0.0	477.0	40.91	458.70	429.88	0.0	-10.48	0.0
	Booster Ascent Prop	-956399									
	Max G Flight Condition	2468012	2535	0.0	506.9	39.21	354.56	327.44	0.0	-23.74	0.0
	Booster Ascent Prop	-886210									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1576042	2673	0.0	581.7	33.18	245.06	223.95	0.0	-35.0	0.0
	ESS Separation	-754885									
	Booster Vent Residuals	-17571									
	Booster	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-2.66	0.0

NOTES:


COMBINED SPACECRAFT C.G. TRAVEL
B-9U + ESS / MDAC SS
(10° GIMBAL)
(6° GIMBAL)
END BOOST
(ENGINE NULL)
MAX Q
MAX G
4° CANT
LIFTOFF
B-9U VERTICAL BODY STATION
700
600
500
400
2000
2100
2200
2300
2400
2500
2600
2700
2800
B-9U LONGITUDNAL BODY STATION
ENGINE GIMBAL STATION 3983
B-9U NOSE STATION 1000
B-9U TANK ℄ STATION 400

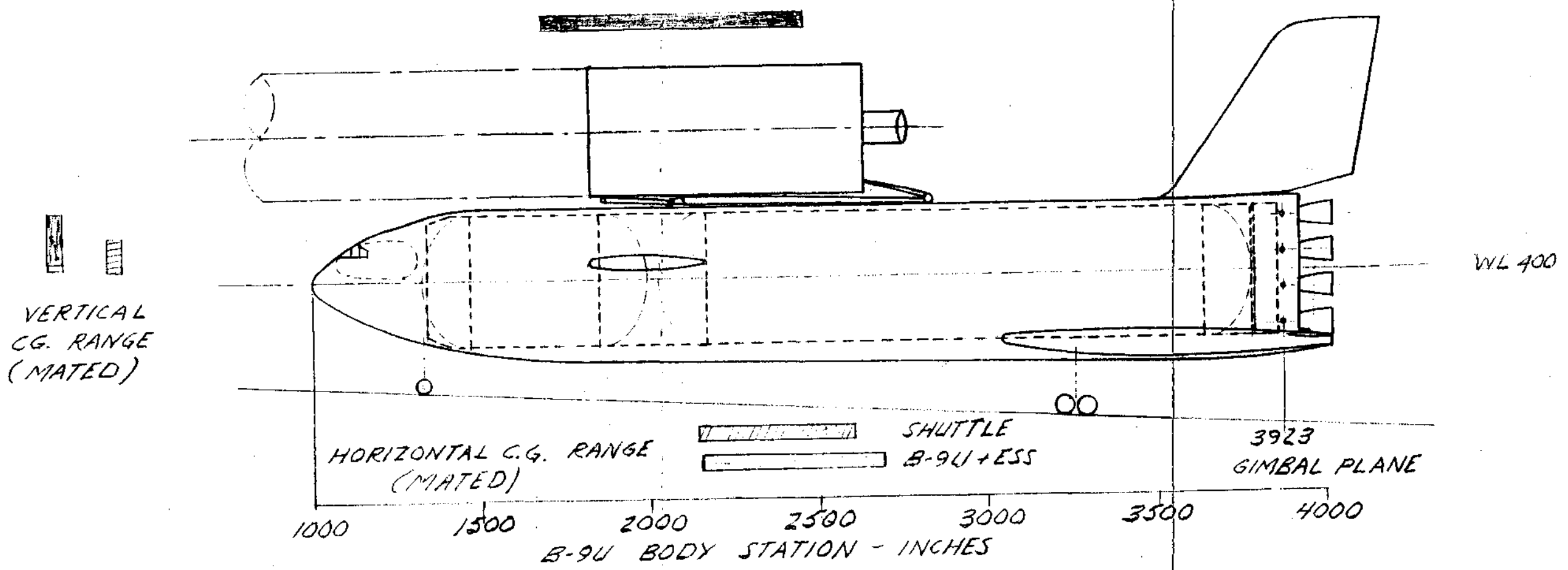

COMBINED SPACECRAFT C.G. TRAVEL
B-94 VERTICAL BODY STATION
B-94 LONGITUDINAL BODY STATION
ENGINE GIMBAL STATION 3939
S-94 NOSE STATION 4000
B-94 TANK & STATION 4180
END BOOST
MAX G
MAX Q
LIFTOFF
5° GRAT
(ENGINE NULL)
(6° GIMBAL)
(10° GIMBAL)
2000
2200
2400
2600
2800
600
500
700


COMBINED SPACECRAFT C.G. TRAVEL
B-9U + ESS / LM TVC
(10° GIMBAL)
(6° GIMBAL)
END BOOST
MAX Q
MAX Q
(ENGINE NULL)
2° CANT
LIFTOFF
B-9U LONGITUDINAL BODY STATION
2000
2100
2200
2300
2400
2500
2600
2700
2800
ENGINE GIMBAL STATION 3923
B-9U NOSE STATION 1000
B-9U TANK 6 STATION 400
B-9U VERTICAL BODY STATION
700
600
500
400


COMBINED SPACECRAFT C.G. TRAVEL
B-9U + ESS/ALTERNATE PAYLOADS
ESS + PAYLOAD = 992000 POUND GROSS
(10° GIMBAL)
○ LH2 TANKER MDAC SHAPE
◇ LO2 TANKER ESS + NOSE CONE
< FILLS - 99,290 LB LH2 IN ENS TANK
(6° GIMBAL)
END BOOST
(ENGINE NULL)
3° CANT
LIFTOFF
MOMENT ARM ABOUT B-9U C.G.
700
600
500
400
2000
2100
2200
2300
2400
2500
2600
2700
2800
B-9U LONGITUDINAL BODY STATION
ENGINE GIMBAL STATION 2923
B-9U NOSE STATION 2000
B-9U TANK ℄ STATION 400

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CENTER OF GRAVITY RANGE
B-9U + ESS/PAYLOAD



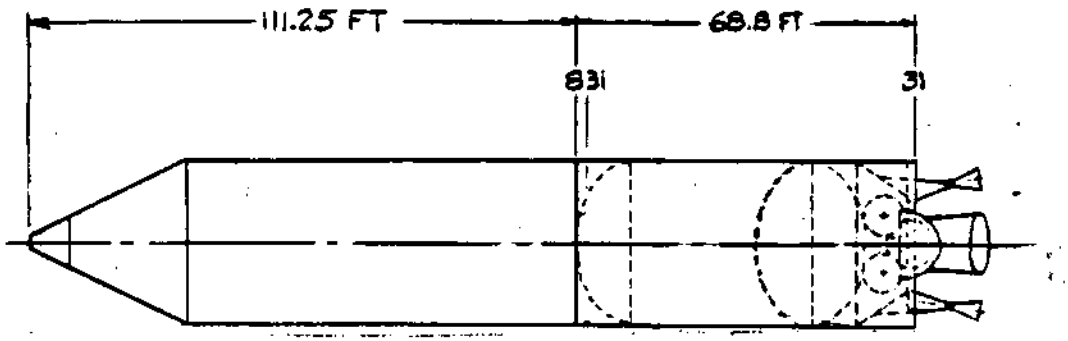
FOLDOUT FRAME 1

FOLDOUT FRAME 2

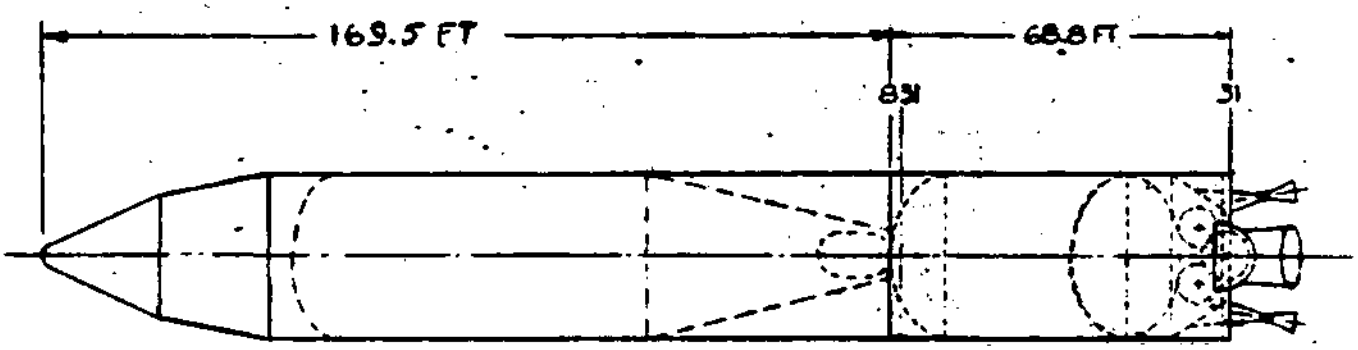
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4.0 EXPENDABLE SECOND STAGE

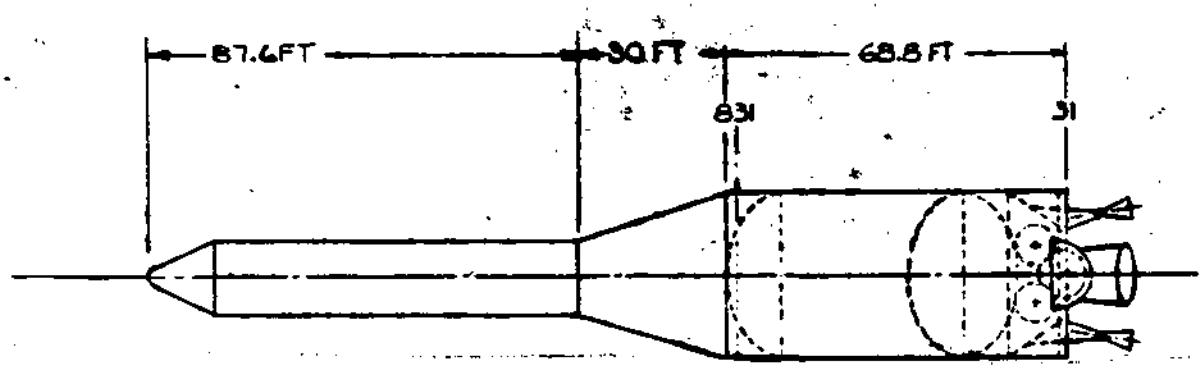
This section presents the mass properties data for the selected expendable second stage/payload combinations. Vehicle weight, centers of gravity, and mass moments of inertia were estimated and tabulated in standardized mass properties reporting format. Flight sequenced mass properties shown in this section are limited to the vehicle operational events occurring after the point of B-9U/ESS separation. Estimated mass properties for the ESS are based on the Saturn S-II vehicle with the modifications necessary to meet the ESS operational requirements. The ESS dry weight is constant for the three configurations. Mass properties variations result from different payloads and mainstage propellant requirements. Center of gravity location is graphically presented relative to time during the ESS flight operations. Payload mass properties were obtained from the Study Control Document, revised Feb. 1, 1971.



ESS + MDAC SPACE STATION



ESS + RNS



ESS + NR SPACE TUG AND ADAPTER

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS-MDAC SPACE STATION		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP								
2.0	TAIL GROUP								
3.0	BODY GROUP					57847	42	21	37
4.0	INDUCED ENVIR PROTECT								
5.0	LANDING, DOCKING								
6.0	PROPULSION, ASCENT					25328	90	10	
7.0	PROPULSION, CRUISE								
8.0	PROPULSION, AUXILIARY					4710	100		
9.0	PRIME POWER					3400	100		
10.0	ELECTRICAL CONV & DISTR					1190	100		
11.0	PNEUMATIC DISTR.					406	10	90	
12.0	SURFACE CONTROLS								
13.0	AVIONICS					2955	100		
14.0	ENVIRONMENTAL CONTROL					1100	100		
15.0	PERSONNEL PROVISION								
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH								
19.0									
	SUBTOTAL (DRY WT)					96936	63	15	22
20.0	PERSONNEL								
21.0	PAYLOAD					176960	100		
22.0	ORDNANCE								
23.0	RESIDUAL FLUIDS					5965	100		
24.0	PAYLOAD MARGIN					5330	100		
	SUBTOTAL (INERT WT)					285191	88	5	7
25.0	RESERVE FLUIDS					6659	100		
26.0	INFLIGHT LOSSES					83	100		
27.0	PROPELLANT-ASCENT					677150	100		
28.0	PROPELLANT-CRUISE								
29.0	PROPELLANT-MANEUV/ACS					22917	100		
30.0									
	TOTAL (GROSS WT) LB					992000	98	1	1

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

FORM 3945-A-13 NEW 8-70

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS - RNS		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP								
2.0	TAIL GROUP								
3.0	BODY GROUP					57847	42	21	37
4.0	INDUCED ENVIR PROTECT								
5.0	LANDING, DOCKING								
6.0	PROPULSION, ASCENT					25328	90	10	
7.0	PROPULSION, CRUISE								
8.0	PROPULSION, AUXILIARY					4710	100		
9.0	PRIME POWER					3400	100		
10.0	ELECTRICAL CONV & DISTR					1190	100		
11.0	PNEUMATIC DISTR.					406	10	90	
12.0	SURFACE CONTROLS								
13.0	AVIONICS					2955	100		
14.0	ENVIRONMENTAL CONTROL					1100	100		
15.0	PERSONNEL PROVISION								
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH								
19.0									
	SUBTOTAL (DRY WT)					96936	63	15	22
20.0	PERSONNEL								
21.0	PAYLOAD					83000	100		
22.0	ORDNANCE								
23.0	RESIDUAL FLUIDS & GASES					5965	100		
24.0	PAYLOAD MARGIN					9314	100		
	SUBTOTAL (INERT WT)					195215	82	8	10
25.0	RESERVE FLUIDS					10480	100		
26.0	INFLIGHT LOSSES					83	100		
27.0	PROPELLANT-ASCENT					428198	100		
28.0	PROPELLANT-CRUISE								
29.0	PROPELLANT-MANEUV/ACS					17724	100		
30.0									
	TOTAL (GROSS WT) LB					651700	94	2	4

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

FORM 3945-A-13 NEW 8-70

SUMMARY WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE
B9U/ESS - NR TUG		

CODE	SYSTEM	BOOSTER	EST	CALC	ACT	ESS	EST	CALC	ACT
1.0	WING GROUP								
2.0	TAIL GROUP								
3.0	BODY GROUP					57847	42	21	37
4.0	INDUCED ENVIR PROTECT								
5.0	LANDING, DOCKING								
6.0	PROPULSION, ASCENT					25328	90	10	
7.0	PROPULSION, CRUISE								
8.0	PROPULSION, AUXILIARY					4710	100		
9.0	PRIME POWER					3400	100		
10.0	ELECTRICAL CONV & DISTR					1190	100		
11.0	PNEUMATIC DISTR.					406	10	90	
12.0	SURFACE CONTROLS								
13.0	AVIONICS					2955	100		
14.0	ENVIRONMENTAL CONTROL					1100	100		
15.0	PERSONNEL PROVISION								
16.0	RANGE SAFETY								
17.0	BALLAST								
18.0	GROWTH								
19.0									
	SUBTOTAL (DRY WT)					96936	63	15	22
20.0	PERSONNEL								
21.0	PAYLOAD					107180	100		
22.0	PAYLOAD ADAPTER					10000	100		
23.0	RESIDUAL FLUIDS					5965	100		
24.0	PAYLOAD MARGIN					9413	100		
	SUBTOTAL (INERT WT)					229494	85	6	9
25.0	RESERVE FLUIDS					18487	100		
26.0	INFLIGHT LOSSES					83	100		
27.0	PROPELLANT-ASCENT					496420	100		
28.0	PROPELLANT-CRUISE								
29.0	PROPELLANT-MANEUV/ACS					10401	100		
30.0									
	TOTAL (GROSS WT) LB					754885	95	2	3

DESIGNATIONS:

EST	% ESTIMATED WEIGHT
CALC	% CALCULATED WEIGHT
ACT	% ACTUAL WEIGHT

NOTES & SKETCHES:

FORM 3945-A-13 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 1 OF 5
ESS - S-II			

1. WING GROUP			CARRY THROUGH	EXPOSED SURFACE		
BASIC STRUCTURE			( )	( )		
TORQUE BOX						
LEADING EDGE						
TRAILING EDGE						
SECONDARY STRUCTURE						
VARIABLE GEOMETRY (INCL ___ LBS MECHANISM)						
DOORS, INSULATION, FAIRINGS						
CONTROL SURFACES			SURFACE	SUPTMECH		
AILERONS-(INCL BAL WT ___ LB)						
T.E. FLAPS						
L.E. FLAPS						
SPOILERS						
SPEED BRAKES						
2. TAIL GROUP			VERTICAL	HORIZ		
BASIC STRUCTURE			( )	( )		
TORQUE BOX						
CARRY THROUGH						
LEADING EDGE						
TRAILING EDGE						
SECONDARY STRUCTURE			( )	( )		
CONTROL SURFACES			SURFACE	SUPTMECH		
RUDDER (INCL BAL WT ___ LB)						
ELEVATOR (INCL BAL WT ___ LB)						
3. BODY GROUP						57847
INTEGRAL TANKAGE					29384	
FUEL TANK				13664		
OXIDIZER TANK				5551		
BETWEEN TANKS (CMN BLKHD)				6349		
INSULATION				3820		
BASIC STRUCTURE	FWD	CTR	AFT	SKIRT		
	(4826)	( )	(12684)	(7500)	25010	
SIDEWALLS	4826		12684			
BULKHEADS						
PARTITIONS						
THRUST STRUCTURE (MAIN ASCENT ENGINE)				7500		
SECONDARY STRUCTURE					3453	
CREW COMPARTMENT						
EQUIPMENT COMPARTMENTS						
RADOME ANTENNAS						
SPEED BRAKES						
ENGINE HEAT PROTECTION				630		
INTERSTAGE (INCL MECH ___ LBS)						
~~DOOR~~ FAIRINGS AND PAINT				1123		
GEAR WING PROVISIONS						
THERMAL REQUIREMENT				1700		

FORM 3945-A-6 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 2 OF 5
ESS - S-II			

4. INDUCED ENVIRONMENT PROTECTION						
THERMAL PROTECTION		WING	TAIL	BODY		
LEADING EDGE NOSE CAP						
SURFACE PROTECTION						
ABLATIVE						
INSULATION						
RADIATIVE PANELS						
SOUND PROTECTION						
5. LANDING, DOCKING			STRUC-			
ALIGHTING GEAR		ROLLING	TURE	CONTROLS		
MAIN						
NOSE						
DOCKING						
AUXILIARY SYSTEMS						
DECELERATION CHUTES						
FLOTATION GEAR						
HANDLING GEAR						
6. PROPULSION - MAIN ASCENT						25328
ENGINE & ACCESSORIES					19480	
ENGINE (AS SUPPLIED)				17620		
GIMBAL SYSTEM				1500		
IGNITION AND CONTROL SYSTEM						
PROPELLANT UTILIZATION SYSTEM						
ACCESSORIES				360		
INSTALLATION, DUCTS, SHROUDS - PURGE					276	
PROPELLANT SYSTEM			FUEL	OXIDIZER	5572	
FILL DRAIN			83	289		
PRESSURIZATION			388	329		
VENT SYSTEM			311	322		
RECIRC. SYSTEM			355	186		
PROPELLANT MANAGEMENT			374	206		
FEED SYSTEMS			1255	964		
VORTEX, FLOW CONTROL SYSTEM						
SUPPORTS AND INSTALL			227	283		
TANKAGE-NONINTEGRAL	TANK	INSULATE	SUPTS			
FUEL						
OXIDIZER						

FORM 3945-A-6 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 3 OF 6
ESS - S-II			

7. PROPULSION - CRUISE BACK							
ENGINE & ACCESSORIES							
ENGINE							
IGNITION AND CONTROL SY							
LUBRICATION SY (DRY)							
ACCESSORIES							
INSTALLATION, DUCTS, SHROUD							
AIR INDUCTION							
ENGINE MOUNTING							
NACELLES PYLONG (INCL ___ LB MECH)							
EXHAUST SY							
PROPELLANT SY							
FILL DRAIN							
PRESSURIZATION (DRY)							
VENT SY							
PUMP							
FEED SY							
TRANSFER SY							
DUMP SY							
SUPPORTS/INSTALLATION							
TANKAGE - NON-INTEGRAL	TANK	INSULATE	SUPTS				
FUEL							
8. PROPULSION - AUXILIARY			ATT CONTROL			MANEU-VER	4710
THRUSTER INSTALLATION			766			1172	
THRUSTER		616		472			
ACCESSORY & SUPPORTS		150		700			
PROPELLANT SY			1234			325	
FILL/DRAIN & VENT				50			
PRESSURIZATION							
VENT							
FEED SYSTEM		1234		275			
DUMP SYSTEM							
SUPPORTS							
TANKAGE						1213	
TANKS				580			
INSULATION				494			
SUPPORTS				139			
9. PRIME POWER	POWER UNIT	MTG/ INSTAL	PROPEL TANK/SYS	TEMP CONTROL	CON-TROLS	TOTAL	3400
BATTERIES	2625	775				3400	
ENGINE/TURBINE							
FUEL CELL							
10. ELECTRICAL							1190
	SUPPLY		CONVER-SION	CONTROL UNITS		335	
EQUIPMENT			300	35			
DISTRIBUTION AND CONTROL CIRCUITRY						755	
UTILITY SYSTEMS							
SUPPORTS/INSTALLATION						100	

FORM 3945-A-6 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 4 OF 5
ESS - S-II			

11. HYDRAULIC , PNEUMATIC	PRIMARY ( )	UTILITY ( )	EMERG ( )				406
POWER SUPPLY							
DISTRIBUTION CONTROL CTR							
TEMPERATURE CONTROL SY							
AUXILIARY SYSTEMS							
SUPPORTS INSTALLATION							
12. SURFACE CONTROLS							
COCKPIT CONTROLS							
FLIGHT CONTROL SY							
SYSTEM ACTUATION	CONTROLS ( )	POWER XMISSION ( )	ACTUATOR ( )	FEEL SY ( )	SUPTS INSTALL ( )	(SEE AVIONICS)	
AILERON							
ELEVATOR							
RUDDER							
T.E. FLAP							
SPEED BRAKE							
	UNITS	CIRCUITRY	COOLING	ANTENNAS	INSTALL		
13. AVIONICS	(1455)	(1025)	( )	(44)	(431)		2955
GUID NAV	346	150			29	525	
FLIGHT CONTROL							
DATA MANAGEMENT	570	100			115	785	
COMMUNICATE	108	75		44	63	290	
CONFIG SEQ							
INSTRUMENTATION	329	590			146	1065	
DISPLAYS							
RANGE SAFETY	102	110			78	290	
14. ENVIRONMENTAL CONTROL							1100
GAS SUPPLY SYSTEM (DRY)							
GAS MANAGEMENT PROCESSING (DRY)							
HEAT TRANSPORT SYSTEM (DRY)							
WATER MANAGEMENT SYSTEM (DRY)							
EQUIPMENT CONTAINERS						1100	
15. PERSONNEL PROVISIONS							
SEATS/RESTRAINT SYS (NO. ___)							
FIXED LIFE SUPPORT EQUIPMENT							
EMERGENCY EQUIPMENT							
CARGO HANDLING							
FURNISHINGS							
16. RANGE SAFETY AND ABORT							
17. BALLAST							
18. GROWTH/UNCERTAINTY							
19. OPEN							
SUBTOTAL (DRY WEIGHT)							(96936)

FORM 3945-A-6 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 5 OF 5
ESS/MDAC SPACE STATION			

	NO.	MAN	GARMENTS	HELMET	PRESS. SUIT	ACCESS-ORIES		
20. PERSONNEL								
CREW	( )							
PASSENGER	( )							
PERSONAL GEAR/ACCESSORIES								
LIFE SUPPORT								
FOOD								
EQUIPMENT - POTABLE								
21. CARGO/PAYLOAD (MDAC SS)								176960
22. ORDNANCE								
23. RESIDUAL & UNUSABLE FLUIDS								5965
ASCENT							5965	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
24. OPEN (PAYLOAD MARGIN)								5330
SUBTOTAL (INERT WEIGHT)								(285191
25. RESERVE FLUIDS								6659
ASCENT							6659	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
26. INFLIGHT LOSSES								83
ASCENT								
CRUISE								
MANEUVER							83	
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
27. PROPELLANT - ASCENT								677150
28. PROPELLANT - CRUISE								
						MANEUV	ACS	
29. PROPELLANT - MANEUV/ACS								22917
TOTAL (GROSS WEIGHT)								1992000

FORM 3945-A-6 NEW 8-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 5A OF 5
ESS/RNS			

	NO.	MAN	GARMENTS	HELMET	PRESS. SUIT	ACCESS-ORIES		
20. PERSONNEL								
CREW	( )							
PASSENGER	( )							
PERSONAL GEAR/ACCESSORIES								
LIFE SUPPORT								
FOOD								
EQUIPMENT - POTABLE								
21. CARGO/PAYLOAD (RNS)								83000
22. ORDNANCE								
23. RESIDUAL & UNUSABLE FLUIDS								5965
ASCENT							5965	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
24. OPEN (PAYLOAD MARGIN)								9314
SUBTOTAL (INERT WEIGHT)								195219
25. RESERVE FLUIDS								10480
ASCENT							10480	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
26. INFLIGHT LOSSES								83
ASCENT								
CRUISE								
MANEUVER							83	
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
27. PROPELLANT - ASCENT								428198
28. PROPELLANT - CRUISE								
						MANEUV	ACS	
29. PROPELLANT - MANEUV/ACS								17724
TOTAL (GROSS WEIGHT)								651709

FORM 3945-A-6 NEW 6-70

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 5B OF 5
ESS/NR TUG			

	NO.	MAN	GARMENTS	HELMET	PRESS. SUIT	ACCESS-ORIES		
20. PERSONNEL								
CREW	( )							
PASSENGER	( )							
PERSONAL GEAR/ACCESSORIES								
LIFE SUPPORT								
FOOD								
EQUIPMENT - POTABLE								
21. CARGO /PAYLOAD (NR TUG)								107180
22. PAYLOAD ADAPTER								10000
23. RESIDUAL & UNUSABLE FLUIDS								5965
ASCENT							5965	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
24. OPEN (PAYLOAD MARGIN)								9413
SUBTOTAL (INERT WEIGHT)								229494
25. RESERVE FLUIDS								18487
ASCENT							18487	
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
26. INFLIGHT LOSSES								83
ASCENT								
CRUISE								
MANEUVER							83	
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
27. PROPELLANT - ASCENT								496420
28. PROPELLANT - CRUISE								
						MANEUV	ACS	
29. PROPELLANT - MANEUV/ACS								10401
TOTAL (GROSS WEIGHT)								754889

FORM 3945-A-6 NEW 8-70

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE OF
ESS/MDAC SPACE STATION			

NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-}		
			X	Y	Z	$I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	57847	344.3	1.0	3.0	0.40	1.03	1.02			
4.	INDUC ENV PROTECT										
5.	LANDING & DOCKING										
6.	ASCENT PROPULSION	25328	72.0	5.4	- 1.3	0.06	0.17	0.20			
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	4710	68.3	23.2	- 28.0	0.02	0.02	0.01			
9.	PRIME POWER	3400	188.6	0.0	0.0	-	0.01	0.01			
10.	ELECTRICAL CONV & DIST	1190	203.4	3.7	14.0	-	0.01	0.01			
11.	PNEUMATIC CONV & DIST	406	215.7	9.5	3.2	-	-	-			
12.	SURFACE CONTROLS										
13.	AVIONICS	2955	323.5	- 10.1	- 51.4	0.02	0.06	0.06			
14.	ENVIRO CONTROL	1100	376.7	0.0	0.0	-	0.03	0.03			
15.	PERSONNEL PROVISIONS										
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	96936	251.8	2.9	- 1.3	0.55	1.65	1.67			
20.	PERSONNEL										
21.	CARGO /PAYLOAD	176900	1355.0	0.0	0.0	0.97	5.05	5.05			
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	5965	280.0	0.0	0.0	-	0.04	0.04			
24.	PAYLOAD MARGIN	5330	1355.0	0.0	0.0	0.03	0.15	0.15			
	SUBTOTAL (INERT WEIGHT)	285191	957.5	1.0	- 0.4	1.56	24.13	24.15			
25.	RESERVE FLUIDS	6659									
26.	INFLIGHT LOSSES	83	55.6	0.0	0.0	-	-	-			
27.	PROPELLANT - ASCENT	677150	288.1	0.0	0.0	-	1.90	1.90			
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS	22917	55.6	0.0	0.0	0.02	0.01	0.01			
30.											
	TOTAL (GROSS WT) LB	992000	475.2	0.3	- 0.1	1.58	46.40	46.42			

NOTES:

FORM 3945-A-14 NEW 8-70

SYSTEMS MASS PROPERTIES

CONFIGURATION ESS/RNS	BY	DATE	PAGE OF

NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-}		
			X	Y	Z	$I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	57847	344.3	1.0	3.0	0.40	1.03	1.02			
4.	INDUC ENV PROTECT										
5.	LANDING & DOCKING										
6.	ASCENT PROPULSION	25328	72.0	5.4	- 1.3	0.06	0.17	0.20			
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	4710	68.3	23.2	- 28.0	0.02	0.02	0.01			
9.	PRIME POWER	3400	188.6	0.0	0.0	-	0.01	0.01			
10.	ELECTRICAL CONV & DIST	1190	203.4	3.7	14.0	-	0.01	0.01			
11.	PNEUMATIC CONV & DIST	406	215.7	9.5	3.2	-	-	-			
12.	SURFACE CONTROLS										
13.	AVIONICS	2955	323.5	- 10.1	- 51.4	0.02	0.06	0.06			
14.	ENVIRO CONTROL	1100	376.7	0.0	0.0	-	0.03	0.03			
15.	PERSONNEL PROVISIONS										
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	96936	251.8	2.9	- 1.3	0.55	1.65	1.67			
20.	PERSONNEL										
21.	CARGO / PAYLOAD	83000	179.0	0.0	0.0	0.70	5.03	5.03			
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	5965	280.0	0.0	0.0	-	0.04	0.04			
24.	PAYLOAD MISSION	9314	179.0	0.0	0.0	0.08	0.55	0.55			
	SUBTOTAL (INERT WEIGHT)	195215	980.1	1.4	- 0.6	1.34	32.09	32.11			
25.	RESERVE FLUIDS	10480									
26.	INFLIGHT LOSSES	83	55.6	0.0	0.0	-	-	-			
27.	PROPELLANT - ASCENT	428198	260.0	0.0	0.0	-	.94	.94			
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS	17724	55.6	0.0	0.0	0.02	0.01	0.01			
30.											
	TOTAL (GROSS WT) LB	651700	470.1	0.4	- 0.2	1.35	48.87	48.88			

NOTES:

FORM 3945-A-14 NEW 8-70

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE OF
ESS/NR TUG			

NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-}		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	57847	344.3	1.0	3.0	0.40	1.03	1.02			
4.	INDUC ENV PROTECT										
5.	LANDING & DOCKING										
6.	ASCENT PROPULSION	25328	72.0	5.4	- 1.3	0.06	0.17	0.20			
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	4710	68.3	23.2	- 28.0	0.02	0.02	0.01			
9.	PRIME POWER	3400	188.6	0.0	0.0	-	0.01	0.01			
10.	ELECTRICAL CONV & DIST	1190	203.4	3.7	14.0	-	0.01	0.01			
11.	PNEUMATIC CONV & DIST	406	215.7	9.5	3.2	-	-	-			
12.	SURFACE CONTROLS										
13.	AVIONICS	2955	323.5	- 10.1	- 51.4	0.02	0.06	0.06			
14.	ENVIRO CONTROL	1100	367.7	0.0	0.0	-	0.03	0.03			
15.	PERSONNEL PROVISIONS										
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	96936	251.8	2.9	- 1.3	0.55	1.65	1.67			
20.	PERSONNEL										
21.	CARGO / PAYLOAD	107180	1415.0	0.0	0.0	0.09	0.76	0.76			
22.	PAYLOAD ADAPTER	10000	1013.0	0.0	0.0	0.04	0.05	0.05			
23.	RESIDUAL FLUIDS	5965	280.0	0.0	0.0	-	0.04	0.04			
24.	PAYLOAD MARGIN	9413	1415.0	0.0	0.0	-	0.07	0.07			
	SUBTOTAL (INERT WEIGHT)	229494	876.7	1.2	- 0.5	0.70	18.53	18.55			
25.	RESERVE FLUIDS	18487									
26.	INFLIGHT LOSSES	83	55.6	0.0	0.0	-	-	-			
27.	PROPELLANT - ASCENT	496420	269.6	0.0	0.0	-	1.18	1.18			
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS	10401	55.6	0.0	0.0	0.01	-	-			
30.											
	TOTAL (GROSS WT) LB	754885	451.2	0.4	- 0.2	0.70	32.70	32.72			

NOTES:

FORM 3945-A-14 NEW 8-70

BODY GROUP (3.0)

INTEGRAL TANK (3.1)

	STRUCTURE					
	FUEL TANK	OXIDIZER TANK	BETWEEN TANKS	COMMON BULKHD	INSULATION	TOTAL
SIDEWALLS						
COVERING						
SKIN	9870					
WELDS						
DOUBLERS						
STIFFENERS	114					
FRAMES	723					
BOLTING RING	833					
BEAM/SHEAR PANEL						
WEB						
STIFFENERS						
BULKHEAD - FORWARD	2029					
WEB						
SKIN						
STIFFENERS						
ATTACH RING						
DOOR/CUTOUTS						
BULKHEAD - AFT		4874				
WEB						
SKIN						
STIFFENERS						
ATTACH RING						
DOOR/CUTOUTS						
INSULATION						
SIDEWALL					3396	
BULKHEAD - FORWARD					424	
- AFT						
BULKHEAD - COMMON				6349		
ANTI-SLOSH						
BAFFLES		601				
ANTI-VORTEX		76				
CONDUIT						
ATTACHMENT	95					
TOTAL-INTEGRAL TANK	13664	5551		6349	3820	
TOTAL-TO BE BROUGHT FORWARD						29384

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BODY GROUP (3.0)

BASIC STRUCTURE (3.2)

	BODY SECTION				
FORWARD STA	FORWARD 856	CENTER	AFT 31	THRUST STRUCTURE	TOTAL
AFT STA	719		283		
SIDEWALL					
UPPER					
SKIN	1680		2823		
STIFFENERS	1040		3909		
LONGERONS					
FRAMES	1616		4002		
JOINTS, SPLICES, FASTENERS	100		300		
FITTINGS	390		1546		
SIDE					
SKIN					
STIFFENERS					
LONGERONS					
FRAMES					
JOINTS, SPLICES, FASTENERS					
LOWER					
SKIN					
STIFFENERS					
LONGERONS					
FRAMES					
JOINTS, SPLICES, FASTENERS					
BULKHEADS - STATION					
LONGITUDINAL PARTITIONS					
FLOORING (STRUCTURAL)					
CLOSEOUT STRUCTURE					
DOCKING STRUCTURE			104		
THRUST STRUCTURE					
THRUST STRUCTURE					
FRAMES				2500	
BEAMS				900	
SKIN PANELS				1600	
BULKHEADS					
LONGITUDINALS				1565	
FITTINGS				840	
JOINTS, SPLICES, FASTENERS				95	
TOTAL-BASIC STRUCTURE	4826		12684	7500	
TOTAL-BROUGHT FORWARD					29384
TOTAL-TO BE BROUGHT FORWARD					54394

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BODY GROUP (3.0)

SECONDARY STRUCTURE (3.3)

	DATA				OPERATING MECHANISM					
	LOCATION	TYPE POWER	AREA FT²	STRUCT	MECH CONT	PWR XMT	ACTUATE	LOCK MECH	EMERG	TOTAL
DOORS & FRAMES										
LANDING										
CARGO										
WINDSHIELD COVER										
PANEL-NON STRUCTURAL										
SKIN & STIFFENERS										
FRAMING										
CARGO DEPLOY DEVICE										
CREW & EQUIPMENT COMP'T										
WINDSHIELD-GLASS										
-FRAMING										
FLOOR -SKIN										
-STIFFENERS										
SIDEWALLS -SKIN										
-STIFFENERS										
CLOSURE BULKHEADS										
LONGITUDINAL PANELS										
BASE HEAT PROTECTION										630
EQUIPMENT COMP'T (UNPRESSURIZED)										
STRUCTURE										
INSULATION										
FAIRINGS AND TUNNEL										900
CARGO ACCESS TUNNEL										
STRUCTURE										
INSULATION										
PAINT AND SEALER										223
MANIPULATOR STATION										
PURGING SYSTEM										
ANTENNA										
RADOME										
ANTENNAS										
SPEED BRAKES										
WING, TAIL, GEAR, ABES PROV.										
WING ATTACH										
TAIL										
GEAR - NOSE										
GEAR - MAIN										
ABES										
INTERSTAGE STRUCTURE										
TOTAL-SECONDARY STRUCTURE (3.3)										1753
TOTAL-BROUGHT FORWARD										54394
TOTAL-TO BE BROUGHT FORWARD										56147

BODY GROUP (3.0)

SECONDARY STRUCTURE (3.1)

	FORWARD	CENTER	AFT	SKIRT	DISTRIB.	TOTAL
THERMAL REQUIREMENT (ALL SYSTEMS)						
BODY						
TUNNEL-INSUL						
NON-PRESSURIZED AREA - INSUL	480		1220			
NON-PRESSURIZED AREA - INSUL						
NON-PRESSURIZED AREA - INSUL						
CARGO DOOR-HYD. PIPING - INSUL						
TOTAL-SECONDARY STRUCTURE	480		1220			
TOTAL-BROUGHT FORWARD						56147
TOTAL-BODY (3.0)						57847

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PROPULSION GROUPS (6.0, 7.0)

ENGINE INSTALLATION (6.1 & 7.1)

		7.1 CRUISE BACK		6.1 ASCENT	
1					
2					
3					
4	ENGINE (AS SUPPLIED)				17620
5	THRUST CHAMBER				
6	NOZZLE				
7	PUMP				
8	GEAR BOX				
9	PUMP				
10					
11	ENGINE HEAT SHIELD				
12	GIMBAL SYSTEM (AIRFRAME MOUNTED)				(1500)
13	PUMP/MOTOR				100
14	ACTUATORS & CONTROLS				700
15	ACCUMULATOR - ARMA PACKAGE				400
16	PLUMBING & FITTINGS				150
17	SUPPORTS				150
18	PLUMBING INSULATION				
19					
20	ACCESSORIES				(636)
21	PURGE SYSTEM				276
22	COOLING SYSTEM				
23	ENGINE SERVICE				360
24					
25	LUBRICATION SYSTEM (AIRFRAME MOUNTED)				
26	TANKS				
27	PLUMBING				
28	INSTALLATION				
29	OIL				
30	CONTROLS				
31					
32	IGNITION & CONTROL SYSTEM				
33	IGNITION SYSTEM				
34	THROTTLE CONTROLS				
35					
36					
37					
38	CHILLDOWN SYSTEM				
39	CONTROL SYSTEM				
40	FUEL SYSTEM				
41	OXIDIZER SYSTEM				
42					
43	PROPELLANT UTILIZATION				
44	SENSORS - FUEL				
45	PROBES				
46	SUPPORT				
47	SENSORS - OXIDIZER				
48	PROBES				
49	SUPPORT				
50	FUEL LEVEL CONTROL				
51	CONTROLS				
52	INSTALLATION				
53	FIRE DETECTION & CONTROL				
54	DETECTION				
55	CONTROL				
56					
57	TOTAL-TO BE BROUGHT FORWARD				19756

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PROPULSION GROUPS (6.0, 7.0)

PROPELLANT SYSTEM (6.3 & 7.3)

	7.3 CRUISE BACK		6.3 ASCENT	
	FUEL		FUEL	OXIDIZER
FILL & DRAIN			(83)	(289)
VALVES			49	49
PLUMBING			34	240
PRESSURIZATION				
PRESSURANT				
BOTTLE				
GAS GENERATOR			(388)	(329)
VALVES			45	27
PLUMBING			343	302
CONTROLS				
VENT SYSTEM			(311)	(322)
VENT VALVES			137	133
PRESSURE RELIEF VALVES				
PLUMBING, FITTINGS			174	189
CONTROLS				
FUEL PUMP (AIRFRAME MTD)				
RECIRCULATION SYSTEM			355	186
PVC DUCTS				
PRE-VALVES				
DISTRIBUTION (FEED SYSTEM)			(1255)	(964)
DUCTS, LINES, FITTING			734	346
VALVES			216	216
INSTALLATION			264	114
INSULATION			41	48
GAUGING				
SUMP AND SCREEN				240
FLOW CONTROL (TRANSFER SYSTEM)				
ANTI GEYSERING				
EXCLUSION RISERS				
ANTI VORTEX - SUMP				
TANK TRANSFER				
DUMP SYSTEM				
VALVES				
PLUMBING				
CONTROLS				
PROPELLANT MANAGEMENT			(374)	(206)
PROBE AND SUPPORTS			157	101
SENSORS AND SUPPORTS			45	5
SYSTEM ELECTRONICS			100	50
WIRING AND CONNECTORS			72	50
INSTRUMENTATION				
SUPPORTS & INSTALLATION			227	283
TOTAL-PROPELLANT SYSTEMS			2993	2579
TOTAL-BROUGHT FORWARD			19756	
TOTAL-TO BE BROUGHT FORWARD			25328	

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PROPULSION GROUP (8.0)

AUXILIARY PROPULSION (8.1 & 8.2)

		8.2 ATTITUDE CONTROL		8.1 MANEUVER	
3					
4	THRUSTERS				
5	THRUSTERS		616		472
6	- ACCESSORIES				200
7	MOUNTING		150		300
8	INSULATION				
9	FAIRING - AERODYNAMIC				
10	- PLUME PROTECTION				
11					
12					
13	GIMBAL SYSTEM				(200)
14	SERVO ACTUATORS & CONTROL				100
15	VALVES				20
16	PLUMBING, FITTINGS				50
17	PLUMBING SUPPORTS				30
18	PLUMBING INSULATION				
19					
20					
21	SUB-TOTAL (LINES 4 THROUGH 20)		766		1172
22					
23		ATTITUDE CONTROL		MANEUVER	
24		FUEL	OXIDIZER	FUEL	OXIDIZER
25	PRESSURIZATION SYSTEM				
26	PRESSURANT				
27	TANK				
28	VALVES - REGULATOR				
29	VALVES - ISO				
30	PLUMBING				
31					
32	DISTRIBUTION (FEED) SYSTEM				
33	PUMPS				
34	ACCUMULATOR	650	230		
35	VALVES - GAS GENERATOR	60	60		
36	VALVES - HEAT EXCHANGER	40	40	25	25
37	PLUMBING	54	50	110	115
38	INSTRUMENTATION/CONTROLS				
39	GAUGING ELECTRONICS				
40	SUPPORTS	30	20		
41	FILL, DRAIN & VENT SYSTEMS				
42	VALVES				
43	VALVES			10	10
44	PLUMBING			15	15
45					
46	PLUMBING SUPPORTS & INSTALLATION				
47					
48	TANKAGE				
49	TANK			450	130
50	TANK - INSULATION			384	110
51	SUPPORTS			89	50
52	SUB-TOTAL (LINES 25 THROUGH 51)	834	400	1083	455
53					
54					
55					
56					
57	TOTAL-AUXILIARY PROPULSION SYSTEMS	2000		2710	

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PRIME ELECTRICAL POWER (9.0)

PRIME ELECTRICAL POWER (9.1)

		ENGINE/ TURBINE	FUEL CELL	BATTERY		TOTAL
3						
4	POWER UNIT					
5	ENGINE/TURBINE					
6	FUEL CELL					
7	PLUMBING					
8	BATTERIES			2625		
9						
10						
11						
12	MOUNTING/INSTALLATION					
13	BATTERY CONTAINER			270		
14	MOUNTING PANEL SHELF			505		
15	SUPPORTS					
16						
17						
18	AIR INDUCTION					
19	EXHAUST SYSTEM					
20						
21						
22						
23	PROPELLANT SYSTEM					
24	PRESSURIZATION					
25	PRESSURANT					
6	BOTTLE					
27	VALVES					
28	PLUMBING					
29	FUEL SYSTEM					
30	FUEL					
31	TANKS					
32	VALVES					
33	PLUMBING					
34	OXIDIZER SYSTEM					
35	OXIDIZER					
36	TANKS					
37	VALVES					
38	PLUMBING					
39						
40	TEMPERATURE CONTROL					
41	LUBRICATION & COOLING SYSTEM					
42	HEAT EXCHANGER					
43	- LINES					
44						
45						
46						
47	INSULATION					
48						
49	CONTROLS					
50	VOLTAGE CONTROLS					
51	ELECTRICAL COUPLING SYSTEM					
52	PROPELLANT SUPPLY					
53	INSTRUMENTATION					
54						
55						
56	SUB TOTAL-PRIME POWER SOURCE SYSTEMS			3400		
57	TOTAL-PRIME POWER SOURCE (9.0)					3400

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ELECTRICAL POWER GERERATION (10.0)

ELECTRICAL POWER GENERATION & DISTRIBUTION (10.0)

	AC		DC	TOTAL
POWER SUPPLY EQUIPMENT				
GENERATORS				
ALTERNATORS				
REMOTE DRIVERS				
POWER CONVERSION EQUIPMENT				
INVERTER (4)	200			
CONVERTER				
TRANSFORMER	100			
TRANSFORMER/RECTIFIER				
BATTERY CHARGER				
POWER CONTROL EQUIPMENT				
VOLTAGE REGULATOR				
GENERATOR CONTROL UNIT				
POWER RELAYS				
TRANSFER SWITCH			35	
POWER DISTRIBUTION CIRCUIT, RELAYS ETC				
CENTRAL D.C. DIST. BOX			80	
LOCAL D.C. DIST. BOX	75			
ELECTRICAL POWER DIST. WIRING				
GN/C WIRING				
DC & M WIRING BUS	100		500	
CD & M WIRING				
UMBILICALS				
UTILITY SYSTEMS				
LIGHTS - INTERIOR				
- EXTERIOR				
- LANDING				
CHECKOUT & TEST SYSTEMS (MULTIFUNCTION)				
EXTERNAL SOURCE				
SUPPORTS	50		50	
SUB TOTAL ELECTRICAL GROUP	525		665	
TOTAL - ELECTRICAL GROUP (10.0)				1190

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HYDRAULIC & PNEUMATIC GROUP (11.0)

HYDRAULIC & PNEUMATIC SYSTEMS (11.0)

	HYDRAULIC				PNEU-	
	UNIT 1	UNIT 2	UNIT 3	UNIT 4	MATIC	TOTAL
POWER SUPPLY EQUIPMENT						
COMPRESSOR/PUMP						
PUMP-RECIRCULATION						
REMOTE PUMP DRIVE/GROUND CHECKOUT						
POWER DISTRIBUTION & CONTROL						
RESERVOIR					50	
AIR BOTTLE						
ACCUMULATOR					16	
FILTERS						
VALVES - RELIEF, CHECK					55	
- VENT, SHUTOFF						
- MISCELLANEOUS					2	
CONTROLS AND WIRING					24	
PLUMBING - FEED LINE					196	
- RETURN LINE						
FLUID IN SYSTEM						
SUPPORTS					63	
TEMPERATURE CONTROL SYSTEM						
HEAT EXCHANGER - HEATER						
- COOLER						
PLUMBING						
INSULATION - RESERVOIR						
AUXILIARY SYSTEM - N_2 PRESSURIZATION						
BOTTLE						
VALVES - REGULATION & RELIEF						
VALVES - CHECK & FILL						
TRANSDUCERS						
PRESSURANT						
SUPPORTS						
SUB TOTAL - SYSTEMS					406	
TOTAL-HYDRAULIC/PNEUMATIC GROUP (11.0)						406

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AVIONICS (13.0)

AVIONICS (13.1)

	UNITS	CIRCUITRY	COOLING	ANTENNAS	INSTALL	TOTAL
GUIDANCE & NAVIGATION						(525)
IMU						
PLATFORM	75					75
POWER SUPPLY	66					66
STAR TRACKER INSTALL						
TRACKER						
CONTROL UNIT						
SUN SHIELD						
RATE GYRO PACKAGE	20					20
BODY RATE SENSOR - PITCH						
- YAW						
- ROLL						
AIR DATA PACKAGE						
AERO SURFACE/TVC						
ATTITUDE/TRANSLATE DRIVERS-2 JET	17					17
THROTTLE DRIVER -4 JET	56					56
TVC GIMBAL SERVO DRIVER	7					7
WIRING AND CONNECTORS		100			29	129
DEORBIT ELECTRONICS	105	50				155
FLIGHT CONTROLS						
CONFIGURATION SEQUENCING						
DATA MANAGEMENT						(785)
CENTRAL PROCESSOR	136				25	161
MAIN STORAGE UNITS	284				50	334
MASS MEMORY UNIT						
ACT SELECT BUFFER	12					12
ACT UNITS	108				40	148
DATA BUS - LCU	30					30
MOUNTING RACKS - UNITS						
ACT UNIT INSTALL						
WIRING AND CONNECTORS		100				100
INSTRUMENTATION						(1065)
SIGNAL CONDITIONERS	284				96	380
FLIGHT RECORDER						
MAINTENANCE RECORDER						
MAIN TIMING UNIT	45				15	60
WIRING		590			35	625
RANGE SAFETY						(290)
COMMAND REC.-DECODER	35				10	45
CONTROL UNITS	11				15	26
EXPLOSIVE DEVICES	56				30	86
CIRCUITRY		110			23	133
TOTAL-SUB ITEMS TO BE BROUGHT FWD	1347	950			368	
TOTAL-TO BE BROUGHT FORWARD						2665

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AVIONICS (13.0)

AVIONICS (13.2)

	UNITS	CIRCUITRY	COOLING	ANTENNAS	INSTALL	TOTAL
COMMUNICATION						(290)
S-BAND POWER AMPLIFIER	32					32
USBE S-BAND TR/REC	38					38
UP-DATA LINK DECODER						
SIGNAL PROCESSOR	17					17
AUDIO CENTER						
UHF ATC (AC)						
INTERROGATOR						
VHF/FM TX/RX	19					19
ANTENNA SELECTOR	2					2
RADAR ALTIMETER						
ATC TRANSPONDER						
VHF RECOVERY BEACON						
O/B LINK						
CABLES + CLAMPS		75			15	90
ANTENNAS						
ALTIMETER						
ATC						
RECOVERY BEACON						
VHF VOICE						
S-BAND				40	40	80
RF NAVIGATION & LANDING						
VHF/FM				4	8	12
DISPLAYS & CONTROLS						
INTEGRAL DISPLAY UNIT (CRT)						
INTEGRAL DISPLAY ELECTRONICS UNIT						
DSKY						
ALFANUMERIC MESSAGE PANEL						
ROTATIONAL HAND CONTROLLER						
ROTAT. HAND CONTROL - INTERCONNECT						
TRANSLATIONAL HAND CONTROL						
PEDAL ASSY						
FLIGHT CONTROL MODE SELECTOR						
LIGHT & EMERGENCY POWER PANEL						
NAVIG. MODE SELECT PANEL						
BACKUP FLIGHT INSTR. PANEL						
THROTTLE CONTROL PANEL						
COMMUNICATIONS PANEL						
CAUTION/WARNING PANEL						
TIME READOUT						
CREW AUDIO PANEL						
PROPELLANT/HYBRID PANEL						
SEQUENCE CONTROL PANEL						
EPS CONTROL PANEL						
EC/LSS CONTROL PANEL						
POWER/DISTRIBUTION CONTROL PANEL						
WIRING						
PANEL STRUCTURE						
TOTAL SUB ITEMS THIS PAGE (13.2)	108	75		44	63	290
TOTAL SUB ITEMS BROUGHT FORWARD	1347	950			368	2665
TOTAL - AVIONICS (13.0)	1455	1025		44	431	2955

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ENVIRONMENTAL CONTROL SYSTEMS (14.0)

ENVIRONMENTAL CONTROL (14.2)

	GAS SUPPLY SYSTEM	GAS MANAGMT PROCESS	HEAT TRANSPORT SYSTEM	WATER MANAGMT SYSTEM	
RADIATOR INSTALLATION					
PANELS					
CONTROLS					
CABIN COOLANT INSTALLATION					
PLUMBING					
VALVES					
FREON PUMP SYSTEM					
PUMPS					
ACCUMULATORS					
PLUMBING					
VALVES					
SUPPORT STRUCTURE					
MISCELLANEOUS INSTALLATIONS					
FUEL CELL - FREON HX					
HYDRAULICS - FREON HX					
ELECTRONICS - INSULATION					
WATER MANAGEMENT					
TANKS					
VALVES, REGULATORS					
MOUNTING PROVISIONS					
INSTRUMENTATION					
CONTAINERS					
FORWARD SKIRT					200
THRUST STRUCTURE					400
MOUNTING PROVISIONS					300
TEMPERATURE PROVISIONS					200
TOTAL - ENVIRONMENTAL CONTROL (14.2)					
TOTAL - BROUGHT FORWARD					
TOTAL - TO BE BROUGHT FORWARD					1100

RESIDUAL & UNUSABLE FLUIDS (23.0)

RESIDUAL & UNUSABLE FLUIDS (23.1)

	HYDRAULIC FLUID	GASES/ PRESS	COOLANT	WATER	PROPEL-LANTS	TOTAL
WING						
VARIABLE GEOMETRY - ACTUATOR						
- PWR XMT						
LANDING GEAR DOOR - ACTUATOR						
- PWR XMT						
TAIL						
VARIABLE GEOMETRY - ACTUATOR						
- PWR XMT						
BODY						
LANDING GEAR DOOR - ACTUATOR						
- PWR XMT						
CARGO DOOR - ACTUATOR						
- PWR XMT						
INDUCED ENVIRONMENT						
PASSIVE COOLANT						
HEAT TRANSPORT COOLANT						
PRESSURANT GAS						
COOLANT - WING						
- TAIL						
- BODY						
LANDING, DOCKING						
SHOCK STRUT - OIL - N.G.						
- M.G.						
RETRACT - ACTUATOR						
- PWR XMT						
BRAKING - PWR XMT						
STEERING- PWR XMT						
EMERG - PRESS GAS						
MAIN ASCENT PROPULSION						
GIMBAL - ACTUATOR	24					24
- PWR XMT	51	12				63
LUBRICATION						
PRESSURANT GAS		2000				2000
CRUISE PROPULSION						
LUBRICATION OIL						
DUCT - ACTUATOR						
- PWR XMT						
NACELLE EXTEND - ACTUATOR						
- PWR XMT						
PRESSURANT GAS						
AUXILIARY PROPULSION						
ACS PRESSURANT						
MANEUVER PRESSURANT		3				3
MANEUVER GIMBAL - ACTUATOR	5					5
- PWR XMT	10					10
TOTAL - RESIDUAL ETC (23.1)	90	2015				2105

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RESIDUAL & UNUSABLE FLUIDS (23.0)

PROPELLANTS (23.3)

	ASCENT	CRUISE	ATTITUDE CONTROL	MANEUVER	TOTAL
TRAPPED PROPELLANTS					
ENGINE					
FUEL	40				
OXIDIZER	680				
LINES					
FUEL	200				
OXIDIZER	800				
TANK					
FUEL	1640				
OXIDIZER (SUMP)	500				
TOTAL-RESIDUAL PROPELLANTS (23.3)					3860
TOTAL-BROUGHT FORWARD					2105
TOTAL-RESIDUAL & UNUSABLE FLUIDS (23.0)					5965

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RESERVE FLUIDS (25.0)

RESERVE FLUIDS (25.1)

MDAC SPACE STATION

	ELECT POWER	ASCENT PROP.	CRUISE PROP.	MANEUV PROP.	ACS PROP.	SERVICE FLUIDS	TOTAL
LOX		5708					5708
LH2		951					951
JP							
FREON							
WATER							
GOX							
N2							
TOTAL-RESERVE FLUIDS (25.1)							6659
TOTAL-RESERVE FLUIDS (25.0)							6659

RESERVE FLUIDS (25.0)

RESERVE FLUIDS (25.1)

RNS MISSION

	ELECT POWER	ASCENT PROP.	CRUISE PROP.	MANEUV PROP.	ACS PROP.	SERVICE FLUIDS	TOTAL
LOX		8983					8983
LH2		1497					1497
JP							
FREON							
WATER							
GOX							
N2							
TOTAL-RESERVE FLUIDS (25.1)							10480
TOTAL-RESERVE FLUIDS (25.0)							10480

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RESERVE FLUIDS (25.0)

RESERVE FLUIDS (25.1)

TUG MISSION

	ELECT POWER	ASCENT PROP.	CRUISE PROP.	MANEUV PROP.	ACS PROP.	SERVICE FLUIDS	TOTAL
LOX		15849					15849
LH2		2638					2638
JP							
FREON							
WATER							
GOX							
N2							
TOTAL-RESERVE FLUIDS (25.1)							18487
TOTAL-RESERVE FLUIDS (25.0)							18487

INFLIGHT LOSSES (26.0)

INFLIGHT LOSSES (26.1)

	HYDRAULIC FLUID	GASES/ PRESS	COOLANT	WATER	PROPEL-LANTS	TOTAL
ASCENT PROPULSION						
GAS VENTED						
DUMPED						
CHILLDOWN						
CRUISE PROPULSION						
LUBRICATION OIL						
GAS VENTED						
START UP						
MANEUVER PROPULSION						
GAS VENTED						
DUMPED						
BOIL OFF/LINE					83	
ATTITUDE CONTROL						
GAS VENTED						
DUMPED						
INDUCED ENVIRO. PROT.						
COOLANT - WING						
- TAIL						
- BODY						
PRIME ELECTRICAL POWER						
FUEL						
OXIDIZER						
ENVIRONMENTAL CONTROL						
OXYGEN						
LEAKAGE/REPRESSURIZATION						
DILUANT						
LEAKAGE/REPRESSURIZATION						
COOLANT - H_2						
WATER - POTABLE						
- WASH						
- COOLING						
HYDRAULIC SYSTEM						
FUEL						
OXIDIZER						
TOTAL-INFLIGHT LOSSES (26.1)					83	
TOTAL-INFLIGHT LOSSES (26.0)						83

[illegible] Exp. 7-1

PROPELLANTS EXPENDED (27.0, 28.0, 29.0)

PROPELLANTS - EXPENDED (27.1, 28.1, 29.1)

MDAC SPACE STATION

	27.0 ASCENT PROP	28.0 CRUISE PROP	29.0 MANEUVER PROP	29.0 ACS PROP		TOTAL
NOMINAL THRUST						
MAIN BURN						
FUEL	96736					
OXIDIZER	580414					
PRE-DOCK MANEUVER			(15346)			
FUEL			2192			
OXIDIZER			13154			
ON-ORBIT MANEUVER						
FUEL						
OXIDIZER						
DE-ORBIT MANEUVER			(3057)			
FUEL			436			
OXIDIZER			2621			
ON-ORBIT ATTITUDE				(3000)		
FUEL				428		
OXIDIZER				2572		
ENTRY ATTITUDE				(1514)		
FUEL				217		
OXIDIZER				1297		
CRUISE						
FUEL						
TOTAL-PROPELLANTS(27.1,28.1,29.1)	677150		18403	4514		
TOTAL-PROPELLANTS EXPENDED (27.0, 28.0, 29.0)						700067

[illegible] Dep. 7-[illegible]

PROPELLANTS EXPENDED (27.0, 28.0, 29.0)

PROPELLANTS - EXPENDED (27.1, 28.1, 29.1)

RNS MISSION

		27.0	28.0	29.0			TOTAL
		ASCENT PROP	CRUISE PROP	MANEUVER PROP	ACS PROP		
5	NOMINAL THRUST						
6	MAIN BURN						
7	FUEL	61171					
8	OXIDIZER	367027					
14	PRE-DOCK MANEUVER			(10607)			
15	FUEL			1515			
16	OXIDIZER			9092			
19	ON-ORBIT MANUEVER						
20	FUEL						
21	OXIDIZER						
24	DE-ORBIT MANEUVER			(3057)			
25	FUEL			436			
26	OXIDIZER			2621			
31	ON-ORBIT ATTITUDE				(2560)		
32	FUEL				366		
33	OXIDIZER				2194		
36	ENTRY ATTITUDE				(1500)		
37	FUEL				214		
38	OXIDIZER				1286		
43	CRUISE						
44	FUEL						
56	TOTAL-PROPELLANTS (27.1, 28.1, 29.1)	428198		13664	4060		
57	TOTAL-PROPELLANTS EXPENDED (27.0, 28.0, 29.0)						445922

SM 121 Exp. 7-1

PROPELLANTS EXPENDED (27.0, 28.0, 29.0)

PROPELLANTS - EXPENDED (27.1, 28.1, 29.1)

TUG MISSION

		27.0	28.0	29.0			
		ASCENT PROP	CRUISE PROP	MANEUVER PROP	ACS PROP		TOTAL
5	NOMINAL THRUST						
6	MAIN BURN						
7	FUEL	70917					
8	OXIDIZER	425503					
14	PRE-DOCK MANEUVER			(2144)			
15	FUEL			306			
16	OXIDIZER			1838			
19	ON-ORBIT MANEUVER						
20	FUEL						
21	OXIDIZER						
24	DE-ORBIT MANEUVER			(4197)			
25	FUEL			600			
26	OXIDIZER			3597			
31	ON-ORBIT ATTITUDE				(2560)		
32	FUEL				366		
33	OXIDIZER				2194		
36	ENTRY ATTITUDE				(1500)		
37	FUEL				214		
38	OXIDIZER				1286		
43	CRUISE						
44	FUEL						
56	TOTAL-PROPELLANTS (27.1, 28.1, 29.1)	496420		6341	4060		
57	TOTAL-PROPELLANTS EXPENDED (27.0, 28.0, 29.0)						506821

DF 121 Exp. 7-1

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION	BY	DATE
ESS - MDAC SPACE STATION		

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP						
2.0	TAIL GROUP						
3.0	BODY GROUP	57847	57847	57847	57847	57847	
4.0	INDUCED ENVIR PROTECT						
5.0	LANDING, DOCKING						
6.0	PROPULSION, ASCENT	25328	25328	25328	7708	7708	
7.0	PROPULSION, CRUISE						
8.0	PROPULSION, AUXILIARY	4710	4710	4710	4710	4710	
9.0	PRIME POWER	3400	3400	3400	3400	3400	
10.0	ELECTRICAL CONV & DIST	1190	1190	1190	1190	1190	
11.0	PNEUMATIC DISTR.	406	406	406	406	406	
12.0	SURFACE CONTROLS						
13.0	AVIONICS	2955	2955	2955	2322	2322	
14.0	ENVIRONMENTAL CONTROL	1100	1100	1100	772	772	
15.0	PERSONNEL PROVISION						
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	GROWTH						
19.0							
	SUBTOTAL (DRY WT)	96936	96936	96936	78355	78355	
20.0	PERSONNEL						
21.0	PAYLOAD	176960	176960	176960			
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	5965	5965	5965			
24.0	PAYLOAD MARGIN	5330	5330	5330			
	SUBTOTAL (INERT WT)	285191	285191	285191	78355	78355	
25.0	RESERVE FLUIDS	6659	6659	6659			
26.0	INFLIGHT LOSSES	83	83				
27.0	PROPELLANT-ASCENT	677150					
28.0	PROPELLANT-CRUISE						
29.0	PROPELLANT-MANEUV/ACS	22917	22917	7571	4571		
30.0							
	TOTAL WEIGHT - LB	992000	314850	299421	82926	78355	

DESIGNATIONS:

ITEM

- A LIFTOFF
- B MAINSTAGE CUTOFF
- C ORBIT INSERTION
- D DEORBIT*
- E REENTRY*
- F

NOTES & SKETCHES

* DEORBIT AND REENTRY CONFIGURATIONS HAVE MAINSTAGE ENGINES AND FOUR GN & C CONTAINERS REMOVED.

FORM 3945-A-3 NEW 8-70

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION	BY	DATE
ESS - RNS		

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP						
2.0	TAIL GROUP						
3.0	BODY GROUP	57847	57847	57847	57847	57847	
4.0	INDUCED ENVIR PROTECT						
5.0	LANDING, DOCKING						
6.0	PROPULSION, ASCENT	25328	25328	25328	7708	7708	
7.0	PROPULSION, CRUISE						
8.0	PROPULSION, AUXILIARY	4710	4710	4710	4710	4710	
9.0	PRIME POWER	3400	3400	3400	3400	3400	
10.0	ELECTRICAL CONV & DIST	1190	1190	1190	1190	1190	
11.0	PNEUMATIC DISTR.	406	406	406	406	406	
12.0	SURFACE CONTROLS						
13.0	AVIONICS	2955	2955	2955	2322	2322	
14.0	ENVIRONMENTAL CONTROL	1100	1100	1100	722	722	
15.0	PERSONNEL PROVISION						
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	GROWTH						
19.0							
	SUBTOTAL (DRY WT)	96936	96936	96936	78355	78355	
20.0	PERSONNEL						
21.0	PAYLOAD	83000	83000	83000			
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	5965	5965	5965			
24.0	PAYLOAD MARGIN	9314	9314	9314			
	SUBTOTAL (INERT WT)	195215	195215	195215	78355	78355	
25.0	RESERVE FLUIDS	10480	10480	10480			
26.0	INFLIGHT LOSSES	83	83				
27.0	PROPELLANT-ASCENT	428198					
28.0	PROPELLANT-CRUISE						
29.0	PROPELLANT-MANEUV/ACS	17724	17724	7117	4557		
30.0							
	TOTAL WEIGHT - LB	651700	223502	212812	82912	78355	

DESIGNATIONS:

ITEM

A LIFTOFF
B MAINSTAGE CUTOFF
C ORBIT INSERTION
D DEORBIT*
E REENTRY*
F

NOTES & SKETCHES

* DEORBIT AND REENTRY CONFIGURATIONS HAVE MAINSTAGE ENGINES AND FOUR GN & C CONTAINERS REMOVED.

FORM 3945-A-3 NEW 8-70

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION	BY	DATE
ESS - NR TUG		

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP						
2.0	TAIL GROUP						
3.0	BODY GROUP	57847	57847	57847	57847	57847	
4.0	INDUCED ENVIR PROTECT						
5.0	LANDING, DOCKING						
6.0	PROPULSION, ASCENT	25328	25328	25328	7708	7708	
7.0	PROPULSION, CRUISE						
8.0	PROPULSION, AUXILIARY	4710	4710	4710	4710	4710	
9.0	PRIME POWER	3400	3400	3400	3400	3400	
10.0	ELECTRICAL CONV & DIST	1190	1190	1190	1190	1190	
11.0	PNEUMATIC DISTR.	406	406	406	406	406	
12.0	SURFACE CONTROLS						
13.0	AVIONICS	2955	2955	2955	2322	2322	
14.0	ENVIRONMENTAL CONTROL	1100	1100	1100	722	722	
15.0	PERSONNEL PROVISION						
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	GROWTH						
19.0							
	SUBTOTAL (DRY WT)	96936	96936	96936	78355	78355	
20.0	PERSONNEL						
21.0	PAYLOAD	107180	107180	107180			
22.0	PAYLOAD ADAPTER	10000	10000	10000	10000	10000	
23.0	RESIDUAL FLUIDS	5965	5965	5965			
24.0	PAYLOAD MARGIN	9413	9413	9413			
	SUBTOTAL (INERT WT)	229494	229494	229494	88355	88355	
25.0	RESERVE FLUIDS	18487	18487	18487			
26.0	INFLIGHT LOSSES	83	83				
27.0	PROPELLANT-ASCENT	496420					
28.0	PROPELLANT-CRUISE						
29.0	PROPELLANT-MANEUV/ACS	10401	10401	8257	5697		
30.0							
	TOTAL WEIGHT - LB	754885	258465	256238	94052	88355	

DESIGNATIONS:

ITEM

A LIFTOFF
B MAINSTAGE CUTOFF
C ORBIT INSERTION
D DEORBIT*
E REENTRY*
F

NOTES & SKETCHES

* DEORBIT AND REENTRY CONFIGURATIONS HAVE MAINSTAGE ENGINES AND FOUR GN & C CONTAINERS REMOVED.

FORM 3945-A-3 NEW 8-70

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION	BY	DATE	PAGE OF
ESS-MDAC SPACE STATION			

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-6}		
			X	Y	Z	$I_{x\cdot x}$	$I_{y\cdot y}$	$I_{z\cdot z}$	I_{xy}	I_{xz}	I_{yz}
	IGNITION	992000	475.8	0.3	- 0.1	1.58	46.22	46.24			
	ASCENT PROP.	- 13629									
	B9U/ESS SEPARATION	978371	477.6	0.3	- 0.1	1.58	46.13	46.15			
	ASCENT PROP.	-663521									
	MAINSTAGE CUTOFF	314850	874.7	0.9	- 0.4	1.58	28.63	28.65			
	OMS/ACS PROP.	- 15429									
	ORBIT INSERTION	299421	930.2	0.9	- 0.4	1.56	25.52	25.55			
	PAYLOAD SEPARATION	-182290									
	ACS PROPELLANTS	- 3000									
	VENT RESIDUALS	- 12624									
	RECOVER ENGINES (MS)	- 17620									
	RECOVER GN&C UNITS (4)	- 961									
	ESS DEORBIT	82926	295.8	3.8	- 1.2	0.51	1.40	1.39			
	OMS DEORBIT PROP.	- 4571									
	ESS REENTRY	78355	309.8	4.0	- 1.3	0.51	1.33	1.33			

NOTES:

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION	BY	DATE	PAGE OF
ESS - RNS			

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-}		
			X	Y	Z	$I_{x\cdot x}$	$I_{y\cdot y}$	$I_{z\cdot z}$	I_{xy}	I_{xz}	I_{yz}
	IGNITION	651700	470.8	0.4	- 0.2	1.35	48.78	48.80			
	ASCENT PROP.	- 13267									
	B9U/ESS SEPARATION	638433	474.1	0.4	- 0.2	1.35	48.67	48.70			
	ASCENT PROP.	-414931									
	MAINSTAGE CUTOFF	223502	868.4	1.3	- 0.6	1.35	36.26	36.28			
	OMS/ACS PROP.	- 10690									
	ORBIT INSERTION	212812	909.3	1.3	- 0.6	1.34	34.66	34.70			
	PAYLOAD SEPARATION	- 92314									
	ACS PROPELLANTS	- 2560									
	VENT RESIDUALS	- 16445									
	RECOVER ENGINES (MS)	- 17620									
	RECOVER GN&C UNITS (4)	- 961									
	ESS DEORBIT	82912	295.8	3.8	- 1.2	.51	1.40	1.39			
	OMS DEORBIT PROP.	- 4557									
	ESS REENTRY	78355	309.8	4.0	- 1.3	.51	1.33	1.33			

NOTES:

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: ESS - NR TUG | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES X	Y	Z	MOMENT OF INERTIA SLUG FT^2 X 10^{-6} $I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	PRODUCT OF INERTIA SLUG FT^2 X 10^{-} I_{xy}	I_{xz}	I_{yz}
	IGNITION	754885	451.5	0.4	- 0.2	.70	32.67	32.69			
	ASCENT PROP.	- 13623									
	B9U/ESS SEPARATION	741262	453.8	0.4	- 0.2	.70	32.63	32.61			
	ASCENT PROP.	- 482797									
	MAINSTAGE CUTOFF	258465	793.7	1.1	- 0.5	.70	21.62	21.64			
	OMS/ACS PROP.	- 2227									
	ORBIT INSERTION	256238	794.0	1.1	- 0.5	.70	21.50	21.52			
	PAYLOAD SEPARATION	- 116593									
	ACS PROPELLANT	- 2560									
	VENT RESIDUALS	- 24452									
	RECOVER ENGINES (MS)	- 17620									
	RECOVER GN&C UNITS (4)	- 961									
	ESS DEORBIT	94052	369.2	3.4	- 1.1	.56	2.47	2.46			
	OMS DEORBIT PROP.	- 5697									
	ESS REENTRY	88355	389.4	3.6	- 1.1	.55	2.34	2.33			

NOTES:

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 1 OF 7

MAX. DYNAMIC PRESSURE, LB/SQ FT 397
MAX. $q\alpha$ PSF DEGREE 1500
ENTRY VELOCITY FT/SEC _____
BALLISTIC COEFFICIENT W/C_dA, LB/SQ FT _____
ENTRY ANGLE DEGREES _____

ULTIMATE LOAD FACTOR	Nx	Ny	Nz	@	WEIGHT, LB
ASCENT	1.4	1.4	1.4		992000
ABORT					
SEPARATION					
ENTRY					
CRUISE					
LANDING					

1. WING GROUP

	INSIDE FUSELAGE	EXPOSED	
GROSS AREA SQ FT	( )	( )	
TORQUE BOX			
LEADING EDGE (FIXED)			
TRAILING EDGE (FIXED)			
MOVABLE SURFACES			
VOLUME · CU FT			

	MAC	ROOT THEORETICAL	BODY JUNCTION	PLATFORM BREAK	TIP
CHORD LENGTH (FT)					
CHORD THICKNESS (FT)					
SPAN BETWEEN CHORDS (FT)					

DIHEDRAL ANGLE (DEG) _____ SPAN BETWEEN DIHEDRAL BASES FT _____
SWEEP BACK ANGLE (MEAN CHORD) _____ 25% CHORD _____
AIRFOIL DESCRIPTION _____
TAPER RATIO _____
THICKNESS/CHORD: ROOT _____ TIP _____
DESIGN LOAD _____
CRITICAL LOAD CONDITION _____

CONTROL SURFACES	TYPE	AREA · SQ FT RETRACT	EXTEND
T.E. FLAPS			
L.E. FLAPS			
SPOILERS			
SPEED BRAKES			

PRIMARY STRUCTURAL MATERIALS	MATERIAL	DESIGN TEMP °F
TORQUE BOX		
LEADING EDGE		
TRAILING EDGE (FIXED)		
MOVABLE SURFACES		

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 2 OF 7

2. TAIL GROUP	INBOARD VERTICAL	OUTBOARD VERTICAL	FWD HORIZONTAL	AFT HORIZONTAL	
EXPOSED AREA FT^2 (TOT)					
TORQUE BOX					
LEADING EDGE (FIXED)					
TRAILING EDGE (FIXED)					
MOVABLE SURFACES					
CARRY THROUGH AREA - FT^2					
EXPOSED SEMI-SPAN - FT					
CARRY THROUGH SPAN - FT					
NO. OF SURFACES/VEHICLE					
VOLUME - CU FT					
PRIMARY STRUCT MATERIAL					
CHORD LENGTH					
ROOT (THEORETICAL) FT					
MAC FT					
BODY, JUNCTION					
TIP, FT					
CHORD MAX. THICKNESS					
ROOT, FT					
TIP, FT					
DIHEDRAL ANGLE, DEGREE					
SWEEPBACK, 25% CHORD					

3. BODY GROUP	FWD BULKHEAD	BARREL	AFT BULKHEAD	COMMON BULKHEAD	
INTEGRAL TANK WETTED AREA - FT^2					9311
OXIDIZER TANK			1350	1386	2736
FUEL TANK	1385	3780		1410	6575
INTER-TANK STRUCTURE					
ULLAGE PRESSURE - PSI	OXIDIZER 29.5		FUEL 29.5		
BASIC STRUCTURE WETTED AREA - FT^2	FWD 1190	CTR	AFT 2265	SKIRT 1010	4465
SIDEWALLS	1190		2265		
BULKHEADS					
PARTITIONS					
THRUST STRUCTURE (MAIN ASCENT ENGINE)				1010	
BODY VOLUME - CU FT (TOTAL)					51600
PRIMARY STRUCTURAL MATERIAL	ALUM.		ALUM.	ALUM.	

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 3 OF 7

3. BODY GROUP (CONTINUED)

MISCELLANEOUS	WETTED AREA-SQ FT	VOLUME CU FT	ULT DES PRESS. DIFF - PSI
CREW COMPARTMENT			
EQUIPMENT COMPARTMENT			
RADOME ANTENNAS			
SPEED BRAKES			
DOORS FAIRINGS			
TANKS - OXIDIZER			
TANKS - FUEL			

4. INDUCED ENVIRONMENT PROTECTION

	WING	HORIZ TAIL	VERT TAIL	BODY	
TOTAL VEH WETTED AREA-FT^2					( )
LEADING EDGE NOSE CAP AREA -SQ FT	( )	( )	( )	( )	( )
MATERIAL					
MATERIAL					
MATERIAL					
SURFACE PROT AREA-SQ FT	( )	( )	( )	( )	
MATERIAL					
MATERIAL					
MATERIAL					
MATERIAL					
MATERIAL					
MATERIAL					
MATERIAL					
MATERIAL					( )
UNPROTECTED AREA-SQ FT	( )	( )	( )	( )	
BASE MATERIAL				( )	
TOTAL VEHICLE VOLUME -CU FT (OUTER MOLDLINE)					( )
VOLUME INSIDE PRIMARY STRUCTURE-CU FT					
TPS VOLUME CU FT					
LEADING EDGE/NOSE CAP RAD-FT					
LEADING EDGE/NOSE CAP MAX. TEMP ^{o}F					
LOWER SURFACE MAX. TEMP ^{o}F					
SIDE SURFACE MAX. TEMP ^{o}F					
UPPER SURFACE MAX. TEMP ^{o}F					

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 4 OF 7

5. LANDING, RECOVERY, DOCKING

ALIGHTING GEAR	NO./VEH	DESIGN LOAD-LB	EXTENDED STRUT LGTH-FT	STROKE FT	PRIMARY MATL	BRAKE MATL
MAIN GEAR						
NOSE GEAR						

MAX. DESIGN LANDING WT - LB _____
LANDING SPEED - KNOTS _____
ANGLE OF ATTACK @ LANDING - DEG _____

LIMIT LANDING SINK SPEED
_____ FT/SEC @ _____ LB LANDING WT
_____ FT/SEC @ _____ LB MAX DESIGN LANDING WT

SEPARATION SYSTEM
DESIGN "q" @ SEPARATION-PSF _____
MAX AXIAL ACCELERATION-g's _____
MAX DESIGN SEPARATION-WT LB _____

DECELERATION CHUTE
DIAMETER - FT _____
NO./VEHICLE _____

6. PROPULSION - MAIN ASCENT

	THRUST-SL	THRUST-VAC	EXP RATIO	I_{sp}-VAC	CHAMB PRES PSI
ENGINE	N/A	632,200	150	459	3000

PROPELLANT SYSTEM	FUEL	OXIDIZER	(OPERATING LIMIT)
ULLAGE PRES - PSI			
PROPEL TYPE	LH_2	LOX	
ULLAGE VOL - FT^3 (MIN)	753	255	( )
PRESSURANT	He - GH_2	He - GOX	
TOTAL TANK VOL - FT^3	37675	12744	( )
USABLE PROP VOL - FT^3 (MAX)	36922	12489	( )
TOTL LEN OF FEEDLINES - FT			

TANKAGE - NONINTEGRAL	NO.	SHAPE	WET AREA SQ FT	VOLUME CU FT
OXIDIZER				
OXIDIZER				
OXIDIZER				
FUEL				
FUEL				
FUEL				

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 5 OF 7

7. PROPULSION - CRUISEBACK

NO. OF ENGINES	
ENGINE THRUST - S.L. STATIC - LB	
SPECIFIC FUEL CONSUMPTION LB/LB - THRUST PER HR. @ NOMINAL CRUISE ALTITUDE - FT	
NOMINAL CRUISE ALTITUDE - FT	
NOMINAL CRUISE SPEED - KNOTS	
CRUISE ALTITUDE ENGINE OUT - FT	
CRUISE SPEED, ENGINE OUT - KNOTS	
CRUISE RANGE (ACTUAL REQ) - NA MI	
CRUISE RANGE (MAX AVAIL - NO HEADWIND, ALL ENGINES UP)	
CRUISE LIFT DRAG RATIO	
ENGINE THRUST SIZED BY	
LIFT COEFFICIENT FOR CRITICAL THRUST CONDITION	

	TYPE	TANK VOL CU FT	TANK MATL	TANK PRES-PSI	BURST FACTOR	NO. OF TANKS
FUEL SYSTEM						
PRESSURIZATION SYSTEM						

AIR INTAKE DUCT - LENGTH-FT	
- DIAMETER-FT	
NACELLE WETTED AREA - EACH-SQ FT	

8. PROPULSION - AUXILIARY

THRUSTERS

	THRUST (VAC)-LB	I_{sp}-SEC	ACS	QUANTITY REQ MANEUVER	COMBIN	
OMS	10000	454		2		
ACS	2100	370		14		

PROPELLANT SYS (ACS)	TYPE	TANK VOL CU FT	TANK MATL	TANK PRES-PSI	BURST FACTOR	NO. OF TANKS
FUEL	GH_2 (ACCUM) 68 Ea		Ti	1000	2.0	2
OXIDIZER	GOX (ACCUM) 13 Ea		Alum	1000	2.0	2
FUEL PRESSURANT						
OXIDIZER PRESS.						
PROPELLANT SYS (MANEUVER)						
FUEL	LH_2	237 Ea	Alum	27	2.0	4
OXIDIZER	LOX	298	Alum	33	2.0	1
FUEL PRESSURANT	GH_2					
OXIDIZER PRESS.	GOX					

9. PRIME POWER

	SPECIFIC POWER		TOTAL POWER		TYPE
BATTERIES	9.6	WATT-HRS/LB	25200	WATT-HRS	Nickel/Silver
ENGINE/TURBINE		HP-HR LB FUEL		HP-HR	
		HP-LB OF ENGINE		HP	
FUEL CELL		WATT-HRS/LB FUEL		WATT-HRS	
		WATTS LB OF FUEL CELL		WATTS	

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 6 OF 7

10. ELECTRICAL POWER CONVERSION/DISTRIBUTION

SYSTEM VOLTAGE 115/200 VOLTS
PEAK POWER 9700 WATTS
AVERAGE POWER TBD WATTS

11. HYDRAULIC POWER CONVERSION DISTRIBUTION

SYSTEM NOMINAL OPER PRESSURE _____ PSI
PEAK POWER _____ HORSEPOWER
AVERAGE POWER _____ HORSEPOWER
TOTAL VOLUME OF FLUID _____ FT^3
FLUID TYPE _____ MAX OPER TEMP - °F _____

12. SURFACE CONTROLS

SURFACE	AREA FT^2	MAX DEFL RATE DEG/SEC	MAX DEFL DEG	DESIGN HINGE MOM. FT/LB	NO/ VEHICLE

13. AVIONICS

14. ENVIRONMENTAL CONTROL

	TOT. STOR VOL-FT^3	STORAGE PRES	TANK MATL	NO. OF TANKS
GAS SUPPLY SYSTEM	( )			( )
PRIMARY OXYGEN				
SECONDARY OXYGEN				
DILUENT				

GAS REQUIREMENT AVERAGE RATES
METABOLIC _____ LB MAN-DAY
LEAKAGE _____ LB DAY
REPRESSURIZE _____ LB REPRESSURIZE
PRESSURIZED SURFACE AREA - FT^3 _____
HEAT TRANSPORT SYSTEM CAPACITY _____ BTU HR (PEAK)
_____ BTU HR (AVE)
RADIATOR AREA _____ SQ FT _____ MATERIAL
WATER MANAGEMENT SYSTEM CAPACITY
DRINKING WATER _____ LB MAN-DAY X _____ MAN DAYS
WASHING _____ LB MAN-DAY X _____ MAN DAYS
COOLING _____ LB BTU X _____ BTU'S

15. PERSONNEL PROVISIONS

16. RANGE SAFETY AND ABORT

FORM 3945-A-7 NEW 8-70

DESIGN DATA SUMMARY

CONFIGURATION	BY	DATE	PAGE 7 OF 7

17. BALLAST

DESIGN CG ENVELOPE FWD _____ %L AFT _____ %L
NOMINAL CG WITHOUT BALLAST _____ %L
NOMINAL CG WITH _____ LB BALLAST = _____ %L
MAX DESIGN LANDING WT-LB _____ @ _____ %MAX CG

18. GROWTH

CURRENT ALLOWANCE _____ LB
CONTRACTORS EST OF ALLOWANCE NEEDED TO GUARANTEE CURRENT PAYLOAD AND GROSS WT _____ LB*
REMAINING GROWTH ALLOWANCE FOR CUSTOMER CHANGES _____ LB

*FOR SYSTEM REQUIREMENTS AS DEFINED BY _____

19. OPEN

20. PERSONNEL

NO. OF CREW _____ ; AVE PERCENTILE MAN _____
NO. OF PERSONNEL _____ ; AVE PERCENTILE MAN _____
TOTAL

21. CARGO

BAY DIA _____ FT CARGO BAY VOLUME _____ CU FT
BAY LGTH _____ FT

22. ORDNANCE

23. RESIDUAL FLUIDS - DEFINE WEIGHT ESTIMATING RATIONALE

24. OPEN

25. RESERVE FLUIDS - DEFINE WEIGHT ESTIMATING RATIONALE

26. INFLIGHT LOSSES - DEFINE WEIGHT ESTIMATING RATIONALE

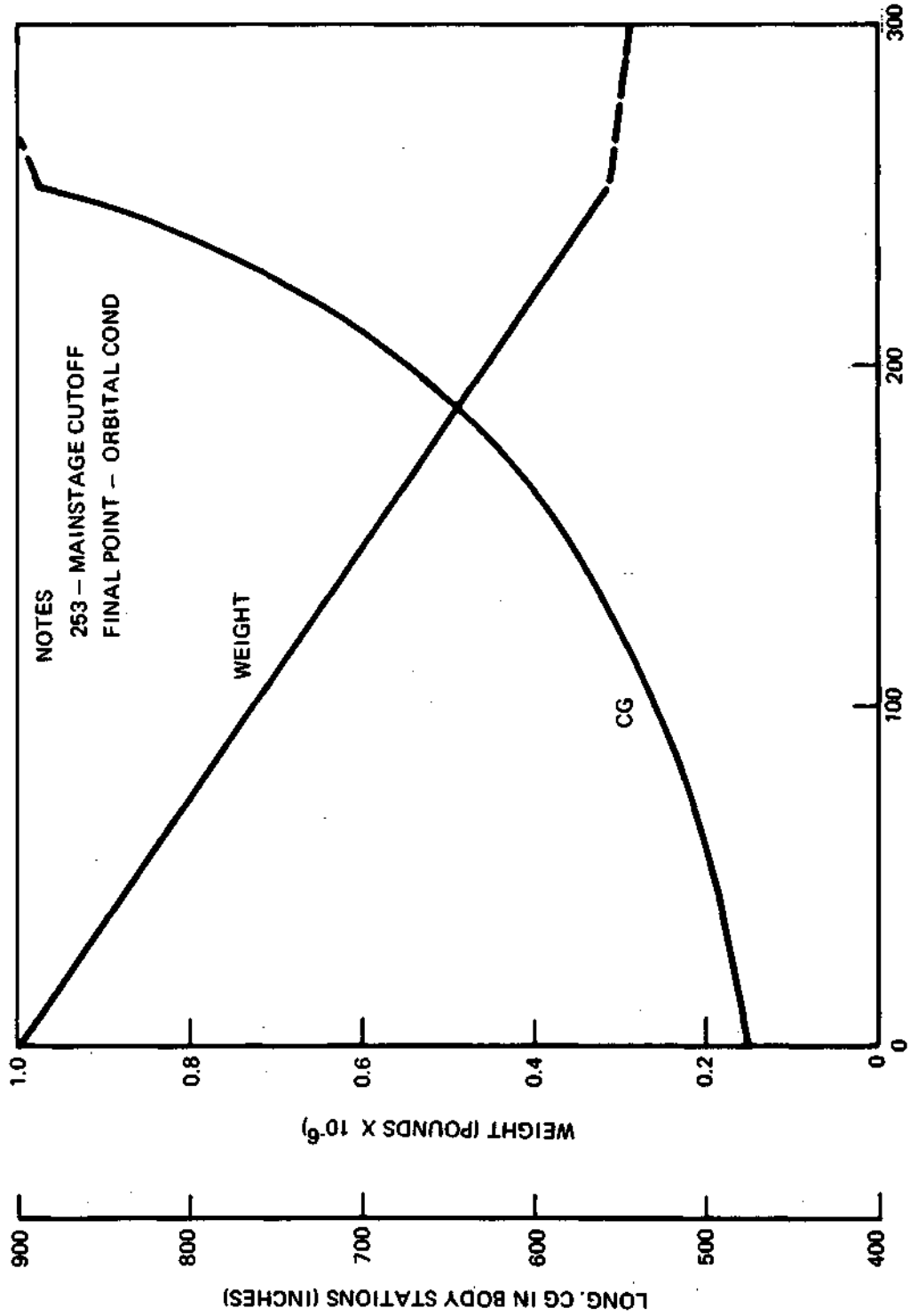
27-29. PROPELLANTS EXPENDED

	ASCENT	CRUISE	MANEUVER	ATTITUDE
OXIDIZER/FUEL RATIO	6.0:1		6.0:1	6.0:1
FUEL DENSITY - PCF	4.40		4.40	4.40
OXIDIZER DENSITY - PCF	71.10		71.10	71.10
INCREMENTAL VELOCITY				
AVE I_{sp}				

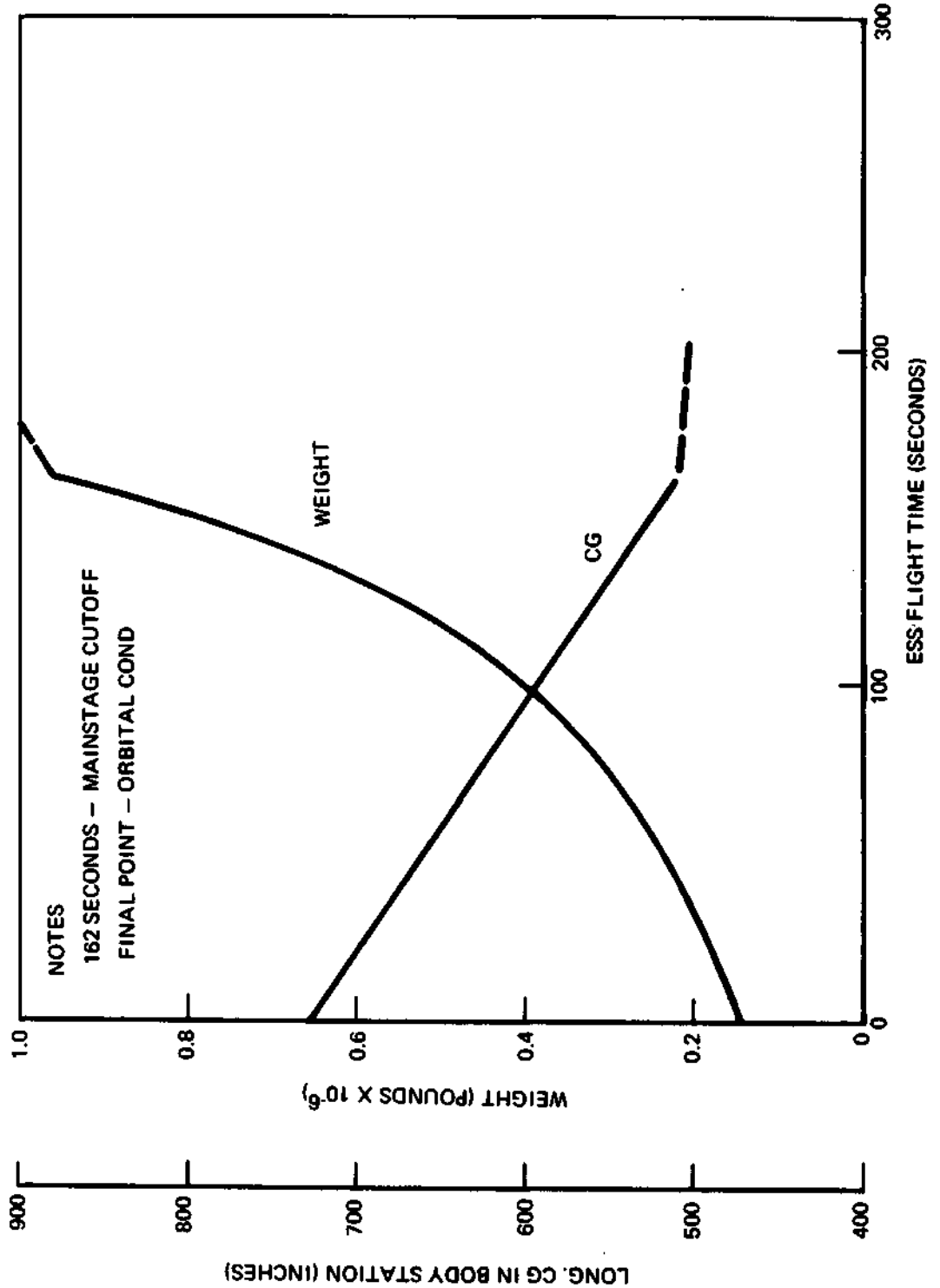
MISSION PERFORMANCE RESERVE _____ % OF _____ LB Wp
CRUISE RESERVE _____ **

**DEFINE BASIS FOR CRUISE RESERVES, I.E., _____ MILES @ _____ POWER _____ KNOT HEADWIND, ETC.

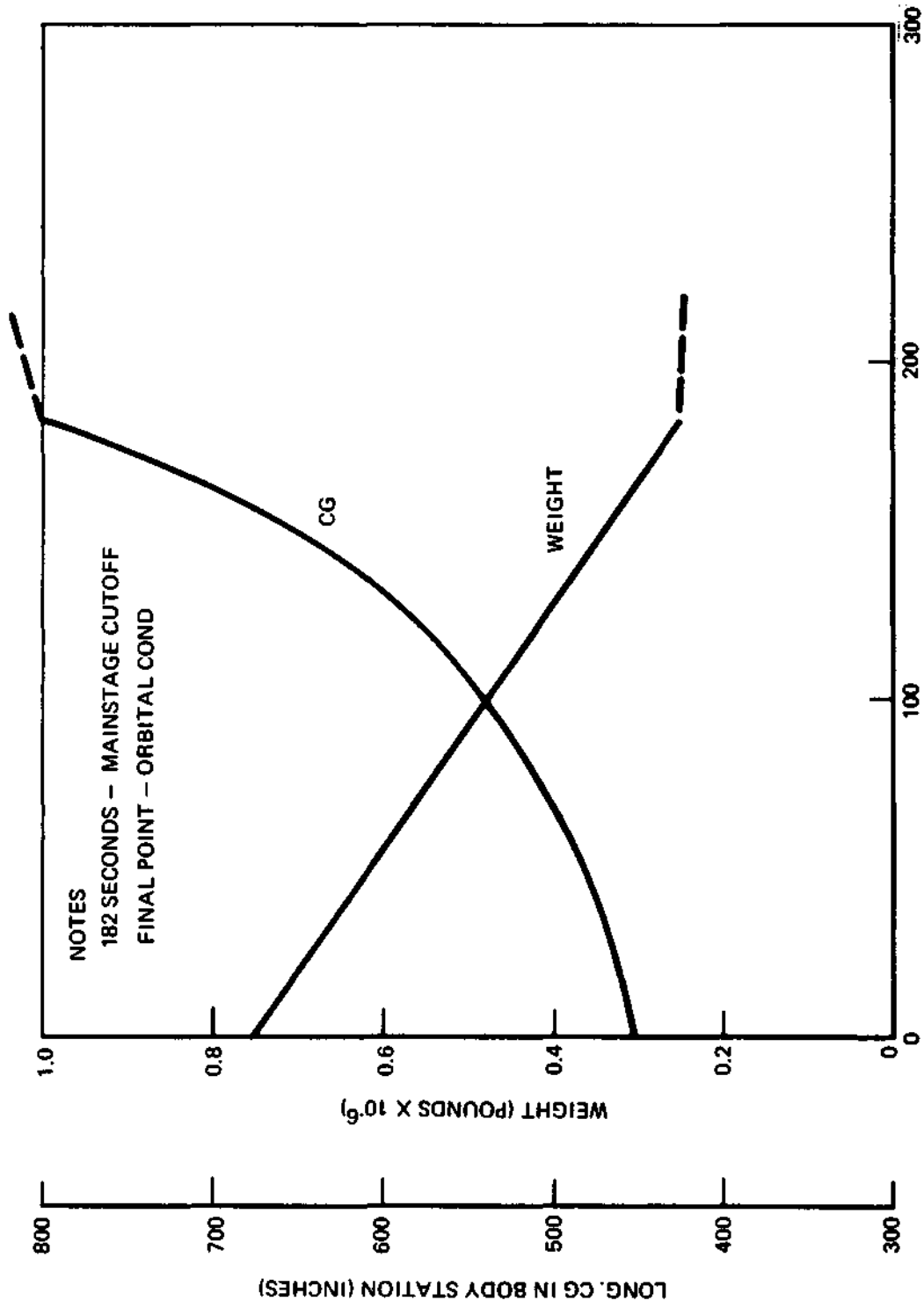
FORM 3945-A-7 NEW 8-70



ESS/MDAC Space Station Mass Properties



ESS/RNS Mass Properties



ESS/Tug Mass Properties

5.0 BOOSTER

Mass properties data for the booster used as a basis for this study were taken from the Space Shuttle Phase B booster configuration designed by the Convair Aerospace Division of General Dynamics, designated B-9U. This vehicle is described in report SD 71-114-2, Volume II, Book 3, dated 26 March 1971, titled "Booster Vehicle Definition." Mass properties for this vehicle are listed in report SD 70-403-8, dated 1 May 1971, titled "Space Shuttle Phase B Definition Mass Properties Status Report."

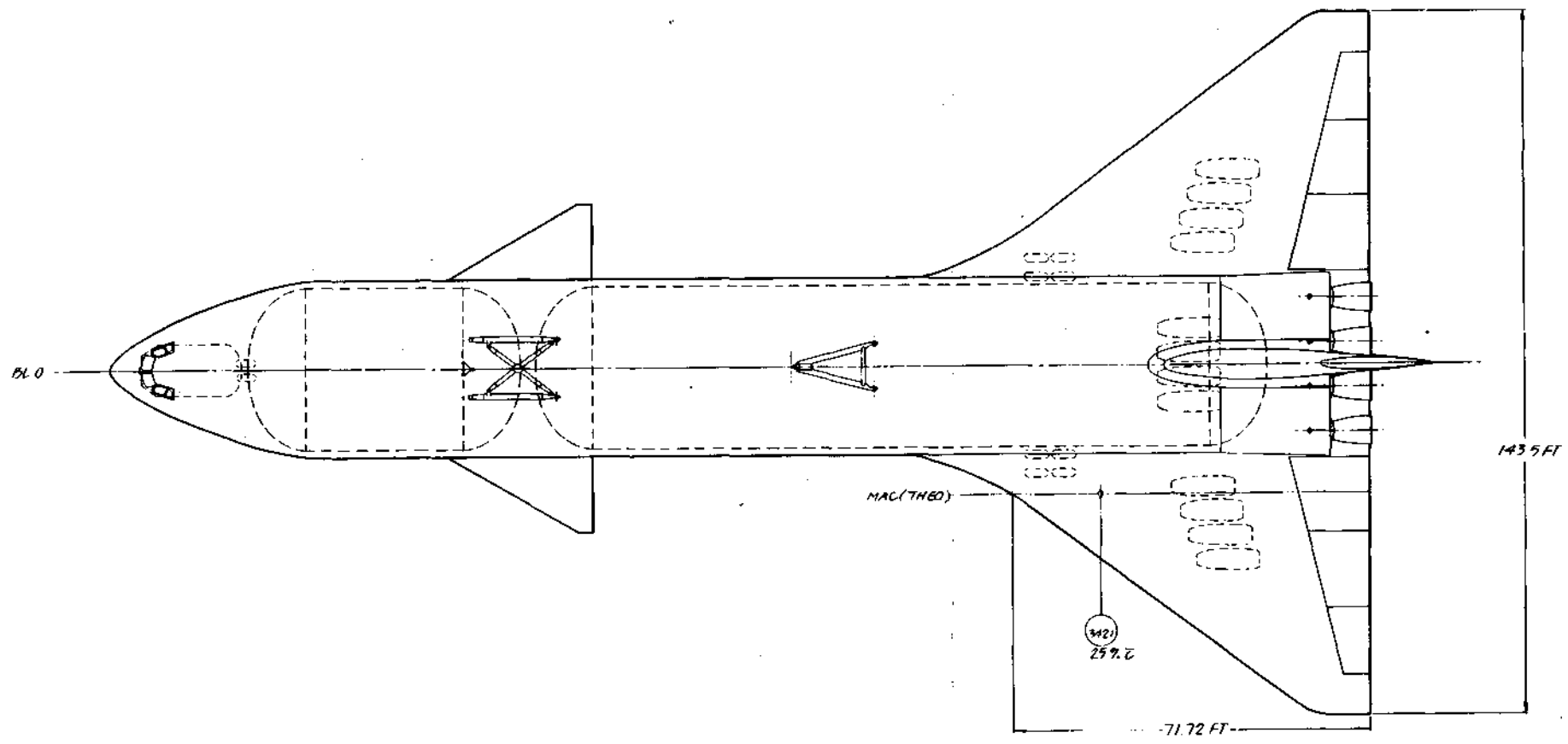
The weight penalties associated with adapting the B-9U booster to ESS payloads total 15,241 pounds. They are of two kinds: 1) permanent (non-removable) weight in the form of beef-up of booster bulkheads to withstand the greater loads imposed by ESS, and 2) substitution of revised attach/separation links and mechanisms, plus a platform, in place of the system used for the reusable orbiter. The bulkhead weight penalties are tabulated below. The combined effect to accommodate all three ESS payloads is a 3181-pound weight increase. This is non-removable weight.

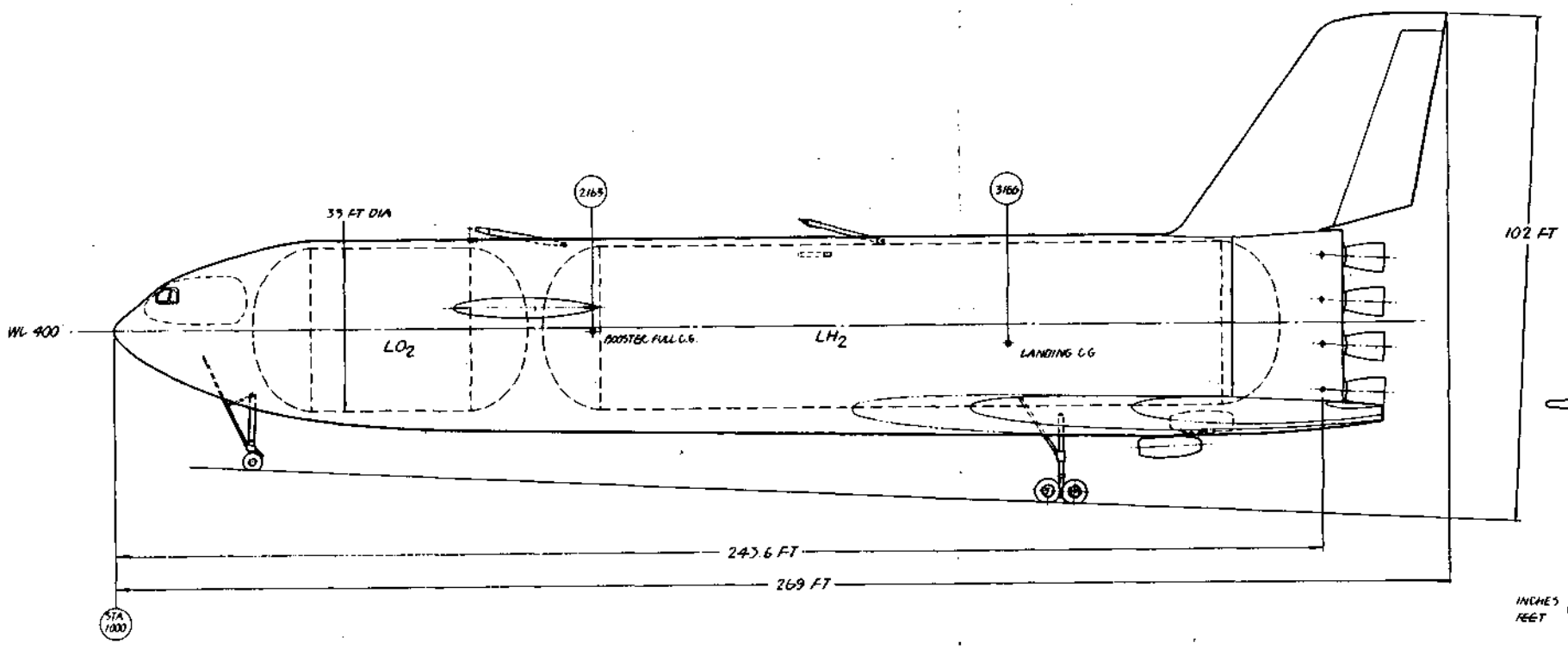
The weight difference between the attach/separation links and mechanism for the ESS payloads is obtaining by subtracting the 4302 pounds of reusable orbiter system and adding a 9770-pound platform plus 6592 pounds of ESS attach/separation links and mechanisms. The weight penalty is therefore 12,060 pounds in this area, which can be removed for reusable orbiter launches by substituting the alternate link-mechanism system.

Detail Weight Changes

Upper Stage	Added Weight (lb)			
	RNS	Space Station	Space Tug	Combined Effect
Station 1866	354	325		354
Station 2866	871	935	879	935
Aft skirt	39	1892	0	1892
Total	1264	3152	879	3181

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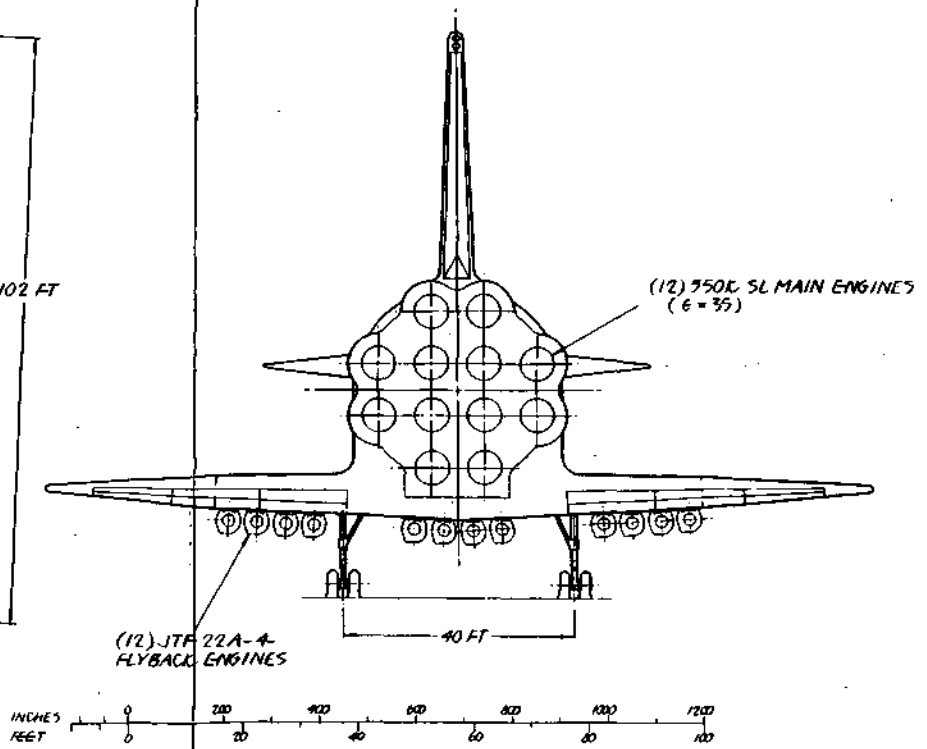


AREAS:

THEO. WING	=	8451 FT²
EXPOSED CANARD	=	504 FT²
VERTICAL TAIL	=	1900 FT²
BODY PLANFORM	=	8728 FT²
BODY WETTED AREA	=	29664 FT²

REFERENCE:

BOOSTER BASIC CONFIG DWG	7620140
BOOSTER INBOARD PROFILE DWG	7620240
BOOSTER LINES DWG	7620241



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FOLDOUT FRAME 1

FOLDOUT FRAME 2

BOOSTER WEIGHT STATEMENT (LAUNCH CONDITION)

CONFIGURATION	BY	DATE

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP	61990	61990	61990	61990		
2.0	TAIL GROUP	19230	19230	19230	19230		
3.0	BODY GROUP	177301	182772	182772	182772		
4.0	INDUCED ENVIR PROTECT	82644	82644	82644	82644		
5.0	LANDING, DOCKING	27361	27361	27361	27361		
6.0	PROPULSION, ASCENT	130186	130186	130186	130186		
7.0	PROPULSION, CRUISE	50413	50413	50413	50413		
8.0	PROPULSION, AUXILIARY	10557	10557	10557	10557		
9.0	PRIME POWER	1801	1801	1801	1801		
10.0	ELECTRICAL CONV & DIST	1438	1438	1438	1438		
11.0	HYDRAULIC CONV & DIST	1862	1862	1862	1862		
12.0	SURFACE CONTROLS	7889	7889	7889	7889		
13.0	AVIONICS	5468	5468	5468	5468		
14.0	ENVIRONMENTAL CONTROL	1650	1650	1650	1650		
15.0	PERSONNEL PROVISION	1600	1600	1600	1600		
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	GROWTH	46486	46486	46486	46486		
19.0	ESS PLATFORM	-	9770	9770	9770		
	SUBTOTAL (DRY WT)	627876	643117	643117	643117		
20.0	PERSONNEL	476	476	476	476		
21.0	CARGO						
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	11476	11476	11476	11476		
24.0							
	SUBTOTAL (INERT WT)	639828	655069	655069	655069		
25.0	RESERVE FLUIDS						
26.0	INFLIGHT LOSSES	20802	20802	20802	20802		
27.0	PROPELLANT-ASCENT	3382307	3382307	2941395	2749260		
28.0	PROPELLANT-CRUISE	143786	143786	143786	143786		
29.0	PROPELLANT-MANEUV/ACS	1500	1500	1500	1500		
30.0							
	TOTAL WEIGHT - LB	4188223	4203464	3762552	3570417		

DESIGNATIONS:

ITEM
- A *Reusable Orbiter
- B Space Station
- C Space Tug
- D Nuclear Stage
- E
- F

NOTES & SKETCHES

*Ref. SD 70-403-8, "Mass Properties Status Report," dated 1 May 1971.

FORM 3945-A-3 NEW 8-70

GENERAL DYNAMICS
Convair Aerospace Division

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 1 OF 5
B-9U DELTA BOOSTER	GD/C		

1. WING GROUP	CARRY THROUGH	EXPOSED SURFACE		61990
BASIC STRUCTURE	(17085)	(30614)	47699	
TORQUE BOX	17085	26646		
LEADING EDGE		3420		
TRAILING EDGE & Tips		548		
SECONDARY STRUCTURE			8178	
VARIABLE GEOMETRY (INCL ___ LBS MECHANISM)				
DOORS, INSULATION, FAIRINGS		8178		
CONTROL SURFACES (Elevons)	SURFACE	SUPTMECH	6113	
AILERONS (INCL BAL WT ___ LB)				
T.E. FLAPS				
L.E. FLAPS				
SPOILERS				
SPEED BRAKES				
	VERTICAL CANARD			
2. TAIL GROUP	(13121)	(6109)		19230
BASIC STRUCTURE	(10992)	(6109)	17101	
TORQUE BOX	9301	3256		
CARRY THROUGH (Pivot)		2189		
LEADING EDGE	866	497		
TRAILING EDGE & Tips	825	167		
SECONDARY STRUCTURE	( )	( )		
CONTROL SURFACES	SURFACE	SUPTMECH	2129	
RUDDER (INCL BAL WT ___ LB)	2129			
ELEVATOR (INCL BAL WT ___ LB)				
3. BODY GROUP				192542
INTEGRAL TANKAGE			92713	
FUEL TANK (Incl. 6226 lb orbiter blkhd & longerons)		67985		
OXIDIZER TANK (Incl. 2470 lb orbiter bulkhead)		17560		
BETWEEN TANKS (CMN BLKHD)				
INSULATION (Fuel Tank)		7168		
BASIC STRUCTURE	Nose (10135) / Fwd Adptr (3652) / Inter-tank (19623)	SKIRT (29678)	63088	
Basic Weight	10135 / 3652 / 14141			
BULKHEADS, Orbiter	/ / 5482			
PARTITIONS	/ /			
THRUST STRUCTURE (MAIN ASCENT ENGINE)		29678		
SECONDARY STRUCTURE			36741	
CREW COMPARTMENT & Avionics Compartment		1800		
EQUIPMENT COMPARTMENTS				
RADOME ANTENNAS				
SPEED BRAKES				
ENGINE HEAT PROTECTION		7869		
INTERSTAGE (INCL MECH ___ LBS) (Links & Mechanisms)		6592		
Platform *		9770		
GEAR WING PROVISIONS (MLG & Wing Bulkheads)		10710		

Alternate Items, for ESS Payloads

* NEW 8-70

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GENERAL DYNAMICS
Convair Aerospace Division

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 2 OF 5
B-9U DELTA BOOSTER	GD/C		

4. INDUCED ENVIRONMENT PROTECTION						82644
THERMAL PROTECTION	WING	Canard	BODY			
LEADING EDGE NOSE CAP						
SURFACE PROTECTION						
ABLATIVE						
INSULATION	3796	382				
RADIATIVE PANELS	12369	1022	65075			
SOUND PROTECTION						
5. LANDING, DOCKING						27361
ALIGHTING GEAR	ROLLING	STRUCTURE	CONTROLS			
MAIN	9200	13200	1356			
NOSE	600	2600	405			
DOCKING						
AUXILIARY SYSTEMS						
DECELERATION CHUTES						
FLOTATION GEAR						
HANDLING GEAR						
6. PROPULSION - MAIN ASCENT						130186
ENGINE & ACCESSORIES					101676	
ENGINE (AS SUPPLIED)(Ref ICD 13M15000B, 3/1/71) (GFE)				89940		
GIMBAL SYSTEM				7910		
IGNITION AND CONTROL SYSTEM(Helium Sys)				3826		
PROPELLANT UTILIZATION SYSTEM						
ACCESSORIES						
INSTALLATION, DUCTS, SHROUDS					1704	
PROPELLANT SYSTEM			FUEL	OXIDIZER	26806	
FILL DRAIN			739	671		
PRESSURIZATION			528	692		
VENT SYSTEM			1098	213		
Conditioning/Recirculating			1161	282		
PRE-VALVES			2100	2100		
FEED SYSTEMS			5662	11560		
VORTEX, FLOW CONTROL SYSTEM						
SUPPORTS AND INSTALL						
TANKAGE-NONINTEGRAL	TANK	INSULATE	SUPTS			
FUEL						
OXIDIZER						

FORM 3-6 NEW 8-70

GENERAL DYNAMICS
Convair Aerospace Division

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 3 OF 5
B-9U DELTA BOOSTER	GD/C		

7. PROPULSION - CRUISE BACK							50413
ENGINE & ACCESSORIES						29150	
ENGINE (GFE)					28140		
IGNITION AND CONTROL SY					950		
LUBRICATION SY (DRY)							
ACCESSORIES - Cooling					60		
INSTALLATION, DUCTS, SHROUD						8913	
AIR INDUCTION					1020		
ENGINE MOUNTING					96		
NACELLES PYLONS (INCL 2325 lb Deploy Mech)					7077		
EXHAUST SY					720		
PROPELLANT SY						2020	
FILL DRAIN					139		
PRESSURIZATION (DRY)							
VENT SY / Dump System					232		
PUMP					160		
FEED SY					546		
TRANSFER SY					720		
DUMP SY							
SUPPORTS/INSTALLATION					223		
TANKAGE - NON-INTEGRAL	TANK	INSULATE	SUPTS			10330	
FUEL - Main	8630		100				
- Fwd	1100		500				
8. PROPULSION - AUXILIARY			ATT CONTROL			MANEU-VER	10557
THRUSTER INSTALLATION			1200				
THRUSTER		1005					
ACCESSORY		195					
PROPELLANT SY			8302				
FILL/DRAIN		246					
PRESSURIZATION / Vent		169					
Conditioning		1869					
FEED SYSTEM		4118					
Exhaust System		1900					
SUPPORTS							
TANKAGE			1055				
TANKS							
INSULATION							
SUPPORTS							

9. PRIME POWER	POWER UNIT	MTG/ INSTAL	PROPEL TANK/SYS	TEMP CONTROL	CON-TROLS	TOTAL	1801
BATTERIES	70	10				(80)	
ENGINE/TURBINE	772	589	360			(1721)	
FUEL CELL						( )	

10. ELECTRICAL	SUPPLY	CONVER-SION	CONTROL UNITS			1438
					272	
EQUIPMENT	112	148	12			
DISTRIBUTION AND CONTROL CIRCUITRY					996	
UTILITY SYSTEMS					92	
SUPPORTS/INSTALLATION					78	

FORM 3945 - NEW 8-70

GENERAL DYNAMICS
Convair Aerospace Division

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 4 OF 5
B-9U DELTA BOOSTER	GD/C		

11. HYDRAULIC	PRIMARY ( )	UTILITY ( )	EMERG ( )	1862			1862
POWER SUPPLY	576						
DISTRIBUTION CONTROL CTR	1134						
TEMPERATURE CONTROL SY							
AUXILIARY SYSTEMS							
SUPPORTS INSTALLATION	152						
12. SURFACE CONTROLS							7889
COCKPIT CONTROLS							
FLIGHT CONTROL SY							
SYSTEM ACTUATION	CONTROLS ( )	POWER XMISSION (1500)	ACTUATOR (5732)	FEEL SY ( )	SUPTS INSTALL (657)	(SEE AVIONICS)	
Elevon		744	3630		428		
Canard		646	1842		202		
RUDDER		110	260		27		
T.E. FLAP							
SPEED BRAKE							
	UNITS	CIRCUITRY	COOLING	ANTENNAS	INSTALL		
13. AVIONICS	(2169)	(2910)	(60)	(39)	(290)		5468
GUID/NAV/Flt. Ctr.	419	230			92	741	
FLIGHT CONTROL							
DATA MANAGEMENT	713	2537	50		40	3340	
COMMUNICATE	388	50		39	75	552	
CONFIG SEQ							
INSTRUMENTATION							
DISPLAYS/ Controls	649	93	10		83	835	
14. ENVIRONMENTAL CONTROL							1650
GAS SUPPLY SYSTEM (DRY)							
GAS MANAGEMENT PROCESSING (DRY)							
HEAT TRANSPORT SYSTEM (DRY)						1245	
Anti-icing, Windshield						45	
Body Ground Purge						360	
15. PERSONNEL PROVISIONS							1600
SEATS/RESTRAINT SYS (NO. 2)						240	
FIXED LIFE SUPPORT EQUIPMENT						20	
EMERGENCY EQUIPMENT						1010	
CARGO HANDLING							
FURNISHINGS						330	
16. RANGE SAFETY AND ABORT							
17.							
18. Contingency							46486
19. OPEN							
SUBTOTAL (DRY WEIGHT)							643117

FORM 3945-A-6 NEW 8-70

GENERAL DYNAMICS
Convair Aerospace Division

GROUP WEIGHT STATEMENT

CONFIGURATION	BY	DATE	PAGE 5 OF 5
B-9U Delta Booster	GD/C	5/11/71	

	NO.	MAN	GARMENTS	HELMET	PRESS. SUIT	ACCESS-ORIES		
20. PERSONNEL								476
CREW	(2)	200			50	10	460	
PASSENGER	( )							
PERSONAL GEAR/ACCESSORIES								
LIFE SUPPORT							16	
FOOD								
EQUIPMENT						16		
21. CARGO								
22. ORDNANCE								
23. RESIDUAL & UNUSABLE FLUIDS								11476
ASCENT 6001 lb GO_2; 850 lb GH_2 @ Landing							6651	
CRUISE 1080 lb JP Fuel; 360 lb Oil							1440	
MANEUVER								
ATTITUDE CONTROL /APU							219	
ECS							50	
~~EPS~~ Helium, Ascent Propulsion Purge							174	
HYDRAULIC							2942	
24. OPEN								
SUBTOTAL (INERT WEIGHT)								655069
25. RESERVE FLUIDS								
ASCENT								
CRUISE								
MANEUVER								
ATTITUDE CONTROL								
ECS								
EPS								
HYDRAULIC								
Included below								
26. INFLIGHT LOSSES								20802
ASCENT (10203 lb O_2; 7238 lb H_2)							17441	
CRUISE Engine Start Cartridges							132	
~~MANEUVER~~ APS/APU Boil-Off							205	
~~ATTITUDE CONTROL~~ APS/APU Propellant Conditioning Losses							1233	
ECS							-	
~~EPS~~ APU							1661	
~~HYDRAULIC~~ Helium, Ascent Propulsion Purge							130	
27. PROPELLANT - ASCENT (Incl. 5760 lb thrust decay propellants which are not included in performance calculations)							*	3382307
28. PROPELLANT - CRUISE								143786
						MANEUV	ACS	
29. PROPELLANT - MANEUV/ACS							1500	1500
TOTAL (GROSS WEIGHT)								4203464

*Space Station uses maximum ascent propellants.
Space Tug is off-loaded 440, 900 lbs.
Nuclear Stage is off-loaded 633, 050 lbs.

FORM 3945-A-6 NEW 6-70

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION	BY	DATE
Ø B-9U DELTA BOOSTER	GDC	

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP	61990					
2.0	TAIL GROUP	19230					
3.0	BODY GROUP	182772					
4.0	INDUCED ENVIR PROTECT	82644					
5.0	LANDING, DOCKING	27361					
6.0	PROPULSION, ASCENT	130186					
7.0	PROPULSION, CRUISE	50413					
8.0	PROPULSION, AUXILIARY	10557					
9.0	PRIME POWER	1801					
10.0	ELECTRICAL CONV & DIST	1438					
11.0	HYDRAULIC CONV & DIST	1862					
12.0	SURFACE CONTROLS	7889					
13.0	AVIONICS	5468					
14.0	ENVIRONMENTAL CONTROL	1650					
15.0	PERSONNEL PROVISION	1600	(SAME FOR ALL ITEMS)				
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	CONTINGENCY	46486					
19.0	ESS PLATFORM	9770					
	SUBTOTAL (DRY WT)	643117					
20.0	PERSONNEL	476					
21.0	CARGO						
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	11476					
24.0							
	SUBTOTAL (INERT WT)	655069	655069	655069	655069	655069	655069
25.0	RESERVE FLUIDS						
26.0	INFLIGHT LOSSES	20802	20802	20802	20802	3231	
27.0	PROPELLANT-ASCENT*	3382307	1969465	1357024			
28.0	PROPELLANT-CRUISE	143786	143786	143786	143786	143786	
29.0	PROPELLANT-MANEUV/ACS	1500	1500	1500	1500		
30.0							
	TOTAL WEIGHT - LB	4203464	2790622	2178181	821157	802086	655069

DESIGNATIONS:

ITEM
- A Liftoff
- B Max Q
- C B-G
- D Burnout (entry)
- E Start cruise return
- F Landing

NOTES & SKETCHES

*Ascent propellants include 5760 lb thrust decay propellants which are not included in performance calculations.

ØAscent propellant loaded for MDAC SS trajectory.

FORM 3945-A-3 NEW 8-70

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION	BY	DATE
∅B-9U DELTA BOOSTER	GDC	

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP	61990					
2.0	TAIL GROUP	19230					
3.0	BODY GROUP	182772					
4.0	INDUCED ENVIR PROTECT	82644					
5.0	LANDING, DOCKING	27361					
6.0	PROPULSION, ASCENT	120186					
7.0	PROPULSION, CRUISE	50413					
8.0	PROPULSION, AUXILIARY	10557					
9.0	PRIME POWER	1801					
10.0	ELECTRICAL CONV & DIST	1438					
11.0	HYDRAULIC CONV & DIST	1862					
12.0	SURFACE CONTROLS	7882					
13.0	AVIONICS	5468					
14.0	ENVIRONMENTAL CONTROL	1650					
15.0	PERSONNEL PROVISION	1600		(SAME FOR ALL ITEMS)			
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	CONTINGENCY	46486					
19.0	ESS PLATFORM	9770					
	SUBTOTAL (DRY WT)	643117					
20.0	PERSONNEL	476					
21.0	CARGO						
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	11476					
24.0							
	SUBTOTAL (INERT WT)	655069	655059	655069	655069	655069	655069
25.0	RESERVE FLUIDS						
26.0	INFLIGHT LOSSES	20802	20802	20802	20802	3231	
27.0	PROPELLANT-ASCENT*	2749260	1597710	1085910	[illegible]		
28.0	PROPELLANT-CRUISE	143786	143786	143786	143786		
29.0	PROPELLANT-MANEUV/ACS	1500	1500	1500	1500		
30.0							
	TOTAL WEIGHT - LB	3570417	2418867	1907067	821157	802086	655069

DESIGNATIONS:

ITEM
- A Liftoff
- B Max Q
- C B-G
- D Burnout (entry)
- E Start cruise return
- F Landing

NOTES & SKETCHES

*Ascent propellants include 5760 lb thrust decay propellants which are not included in performance calculations.

∅Ascent propellant loaded for RNS trajectory.

FORM 3945-A-3 NEW 8-70

SEQUENCE SUMMARY WEIGHT STATEMENT

CONFIGURATION: Ø B-9U DELTA BOOSTER | BY: GDC | DATE:

CODE	SYSTEM	A	B	C	D	E	F
1.0	WING GROUP	61990					
2.0	TAIL GROUP	19230					
3.0	BODY GROUP	182772					
4.0	INDUCED ENVIR PROTECT	82644					
5.0	LANDING, DOCKING	27361					
6.0	PROPULSION, ASCENT	130186					
7.0	PROPULSION, CRUISE	50413					
8.0	PROPULSION, AUXILIARY	10557					
9.0	PRIME POWER	1801					
10.0	ELECTRICAL CONV & DIST	1438					
11.0	HYDRAULIC CONV & DIST	1862					
12.0	SURFACE CONTROLS	7889					
13.0	AVIONICS	5468					
14.0	ENVIRONMENTAL CONTROL	1650					
15.0	PERSONNEL PROVISION	1600	(SAME FOR ALL ITEMS)				
16.0	RANGE SAFETY						
17.0	BALLAST						
18.0	CONTINGENCY	46486					
19.0	ESS PLATFORM	9770					
	SUBTOTAL (DRY WT)	643117					
20.0	PERSONNEL	476					
21.0	CARGO						
22.0	ORDNANCE						
23.0	RESIDUAL FLUIDS	11476					
24.0							
	SUBTOTAL (INERT WT)	655069	655069	655069	655069	655069	655069
25.0	RESERVE FLUIDS						
26.0	INFLIGHT LOSSES	20802	20802	20802	20802	3231	
27.0	PROPELLANT-ASCENT *	2941395	1848369	891970			
28.0	PROPELLANT-CRUISE	143786	143786	143786	143786	143786	
29.0	PROPELLANT-MANEUV/ACS	1500	1500	1500	1500		
30.0							
	TOTAL WEIGHT - LB	3762552	2669526	1713127	821157	802086	655069

DESIGNATIONS:

ITEM
- A Liftoff
- B Max Q
- C B-G
- D Burnout (entry)
- E Start cruise return
- F Landing

NOTES & SKETCHES

*Ascent propellants include 5760 lb thrust decay propellants which are not included in performance calculations.

ØAscent propellant loaded for NR tug trajectory.

FORM 3945-A-3 NLW 8-70

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: B-9U BOOSTER + ESS/MDAC SS | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES X	Y	Z	MOMENT OF INERTIA SLUG FT^2 X 10– $I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	PRODUCT OF INERTIA SLUG FT^2 X 10– I_{xy}	I_{xz}	I_{yz}
	Liftoff	5195464	2161	0.0	471.3	50.82	636.74	598.93	0.0	8.30	0.0
	Booster Ascent Prop	-1412842									
	Max q Flight Condition	3782622	2341	0.0	498.0	48.70	493.08	457.41	0.0	-10.12	0.0
	Booster Ascent Prop	-612441									
	Max G Flight Condition	3170181	2427	0.0	516.9	47.18	430.57	396.40	0.0	-19.41	0.0
	Booster Ascent Prop	-1351264									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1813157	2604	0.0	616.8	37.25	273.82	249.57	0.0	-40.76	0.0
	ESS Separation	-992000									
	Booster Vent Residuals	- 17571									
	Booster ACS Prop	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-2.66	0.0

NOTES:

FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: B-9U BOOSTER + ESS/RNS | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES X	Y	Z	MOMENT OF INERTIA SLUG FT^2 X 10– $I_{x\text{-}x}$	$I_{y\text{-}y}$	$I_{z\text{-}z}$	PRODUCT OF INERTIA SLUG FT^2 X 10– I_{xy}	I_{xz}	I_{yz}
	Liftoff	4222117	2242	0.0	451.4	39.02	563.34	537.14	0.0	-1.18	0.0
	Booster Ascent Prop	-1151550									
	Max q Flight Condition	3070567	2413	0.0	470.8	38.11	446.14	420.85	0.0	-1.30	0.0
	Booster Ascent Prop	-511800									
	Max G Flight Condition	2558767	2503	0.0	485.0	37.5	390.46	365.84	0.0	-25.27	0.0
	Booster Ascent Prop	-1080150									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1472857	2694	0.0	562.9	32.11	257.51	238.20	0.0	-34.03	0.0
	ESS Separation	-651700									
	Booster Vent Residuals	- 17571									
	Booster ACS Prop	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-2.66	0.0

NOTES:

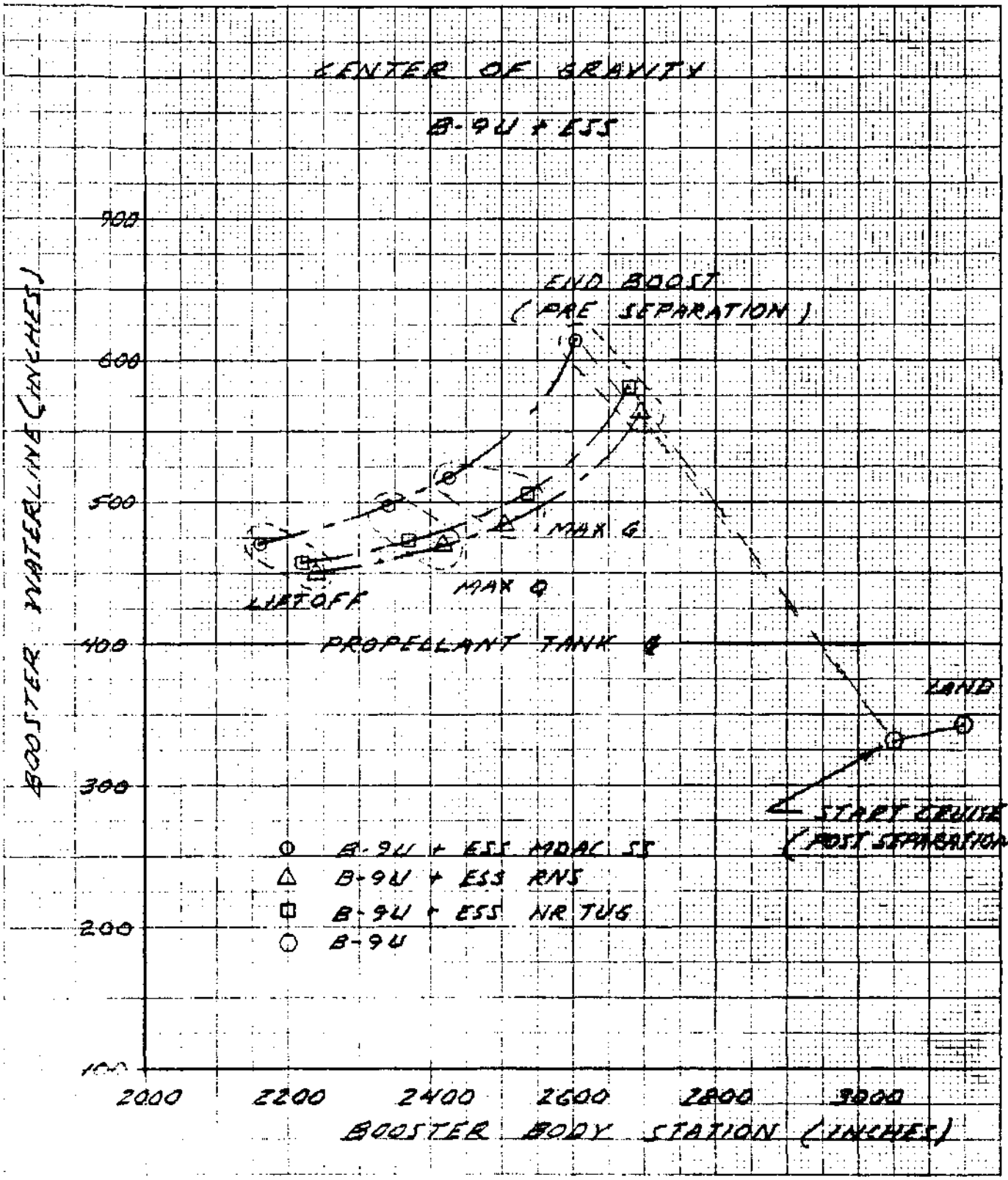
FORM 3945-A-2 NEW 8-70

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: B-9U BOOSTER + ESS/NR TUG | BY | DATE | PAGE OF

NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES X	Y	Z	MOMENT OF INERTIA SLUG FT^2 X 10– I_{x-x}	I_{y-y}	I_{z-z}	PRODUCT OF INERTIA SLUG FT^2 X 10– I_{xy}	I_{xz}	I_{yz}
	Liftoff	4517437	2219	0.0	458.4	41.97	569.71	539.84	0.0	1.80	0.0
	Booster Ascent Prop	-1093026									
	Max q Flight Condition	3424411	2372	0.0	477.0	40.91	458.70	429.88	0.0	-10.48	0.0
	Booster Ascent Prop	-956399									
	Max G Flight Condition	2468012	2535	0.0	506.9	39.21	354.56	327.44	0.0	-23.74	0.0
	Booster Ascent Prop	-886210									
	Booster Thrust Decay	- 5760									
	Booster Burnout	1576042	2673	0.0	581.7	33.18	245.06	223.95	0.0	-35.0	0.0
	ESS Separation	-754885									
	Booster Vent Residuals	-17571									
	Booster	- 1500									
	Booster Start Cruise	802086	3049	0.0	332.0	9.99	129.50	130.70	0.0	-3.24	0.0
	Booster APU Prop	- 3231									
	Cruise Fuel (JP)	-143786									
	Booster Landing(Gear Down)	655069	3146	0.0	344.0	9.63	103.90	105.30	0.0	-2.66	0.0

NOTES:


CENTER OF GRAVITY
B-9U + ESS
END BOOST
(PRE SEPARATION)
MAX Q
LIFTOFF
MAX Q
PROPELLANT TANK
LAND
START CRUISE
(POST SEPARATION)
B-9U + ESS MDAC SS
B-9U + ESS RNS
B-9U + ESS NR TUG
B-9U
BOOSTER WATERLINE (INCHES)
BOOSTER BODY STATION (INCHES)
2000
2200
2400
2600
2800
3000

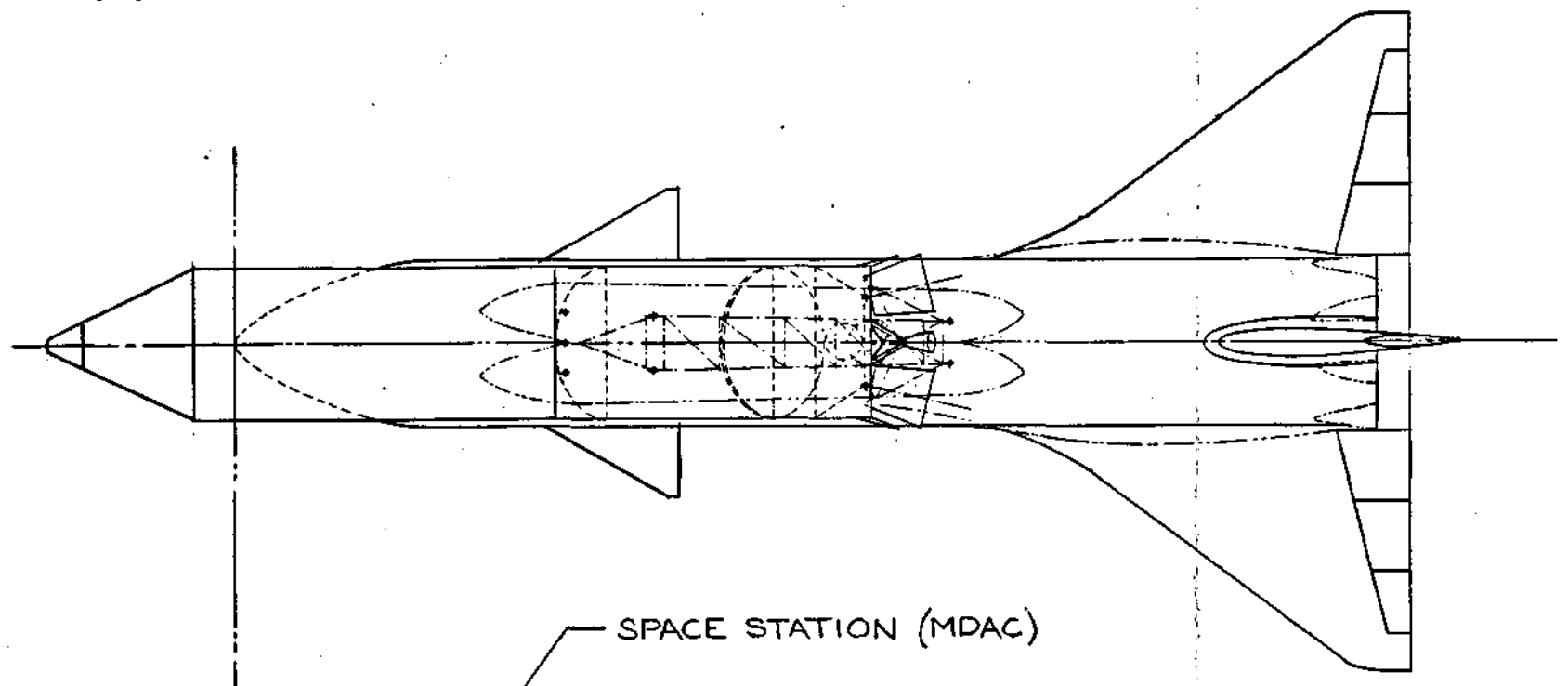
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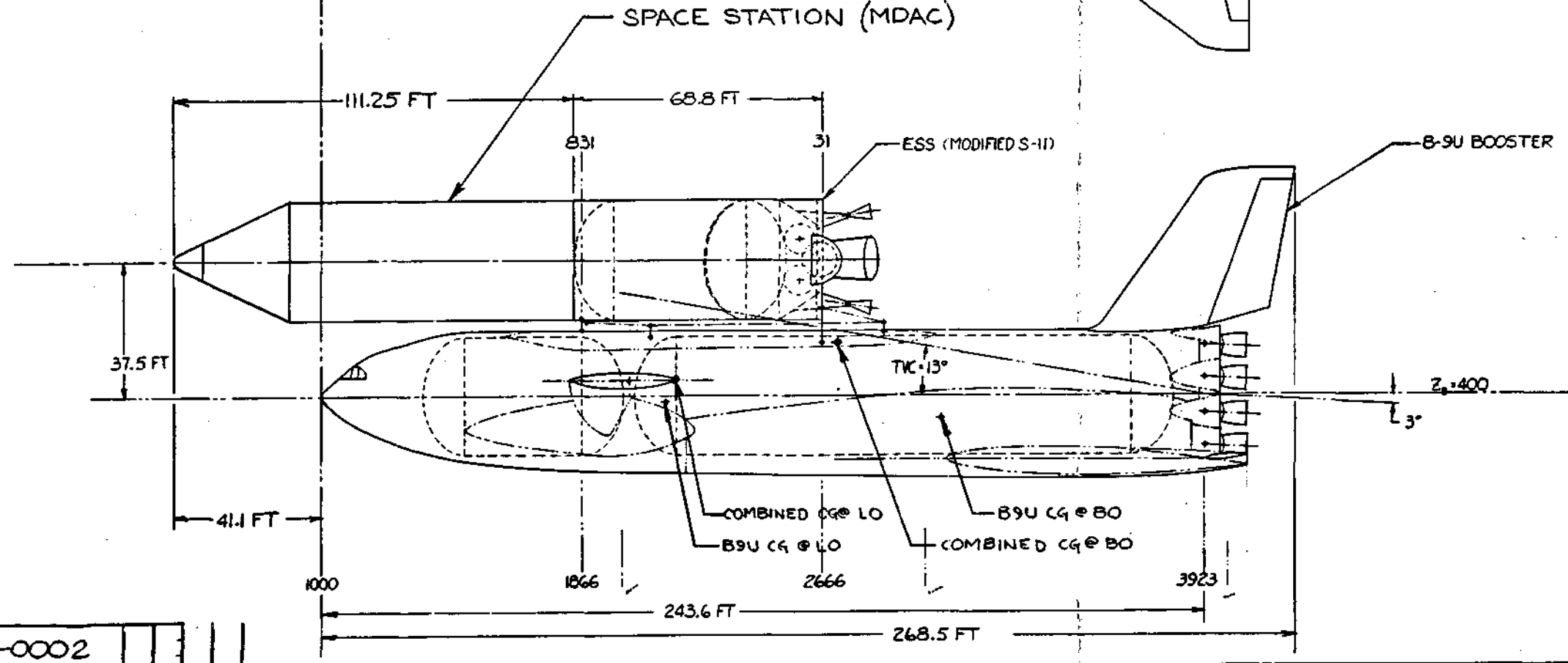
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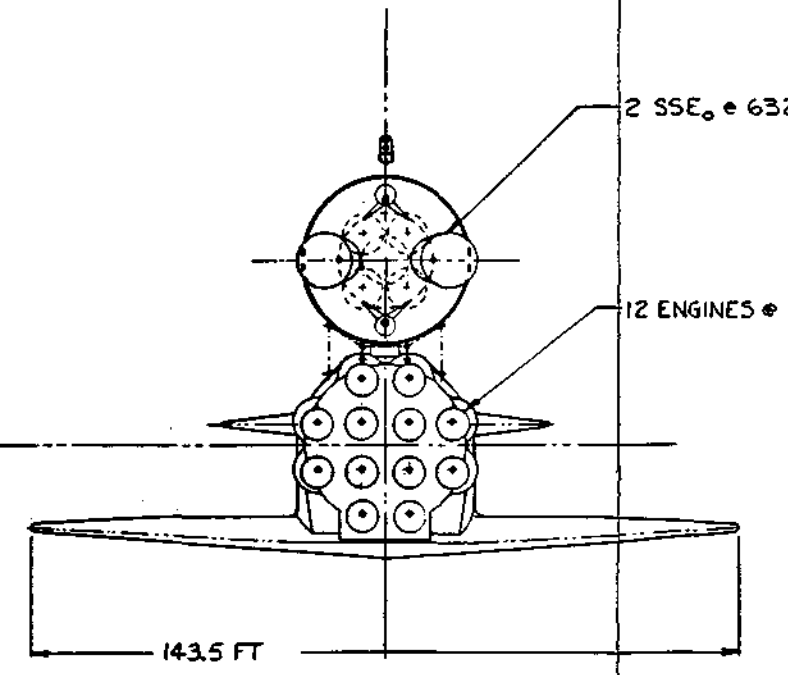
REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED

CONFIGURATION LIFT-OFF WEIGHTS (lbs)

B-9U BOOSTER	4,203,464
ESS	815,040
PAYLOAD	176,960
TOTAL	5,195,464







DR BY	B. Beyler	6-14-71	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 12214 LAKEWOOD BOULEVARD • DOWNEY, CALIFORNIA 90241
CHK BY			EXPENDABLE SECOND STAGE (ESS) B-9U/ESS/SPACE STATION MATED CONFIGURATION-3 VIEW
APPROVED BY			SIZE L · CODE IDENT NO. 03953 · DRAWING NO. S080-0002 · SCALE 1/2 · SHEET

S080-0002

S080-0002

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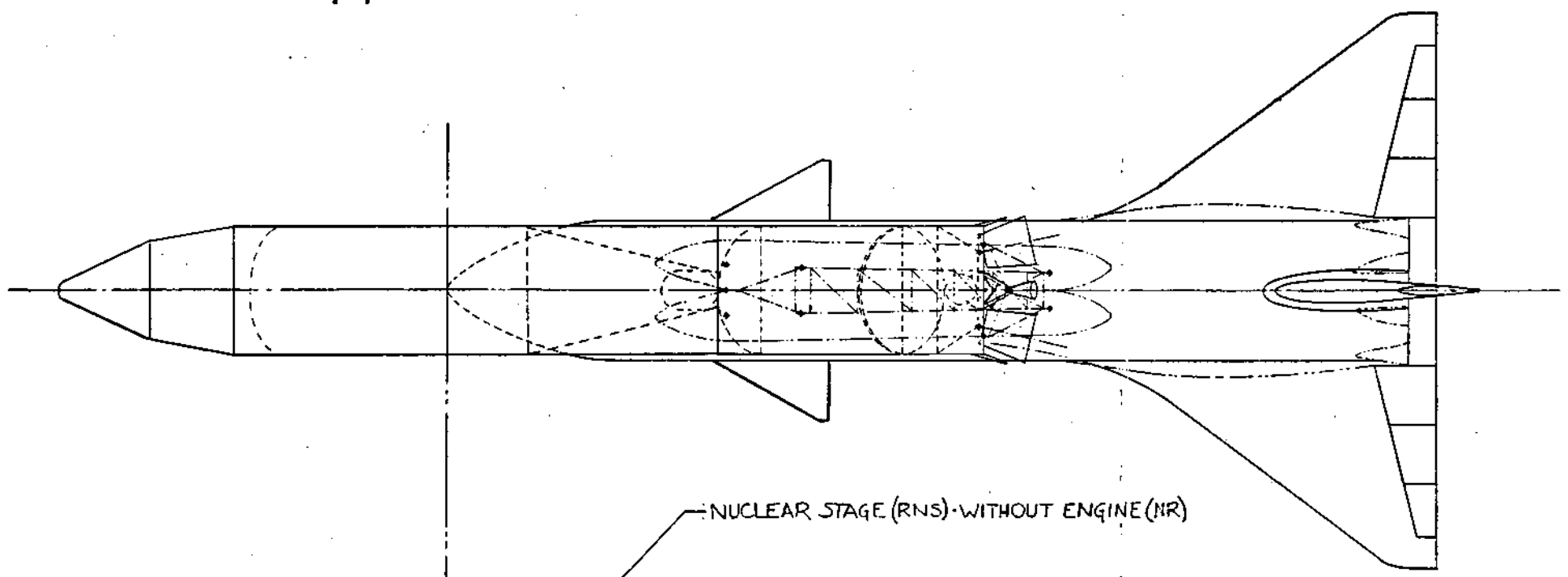
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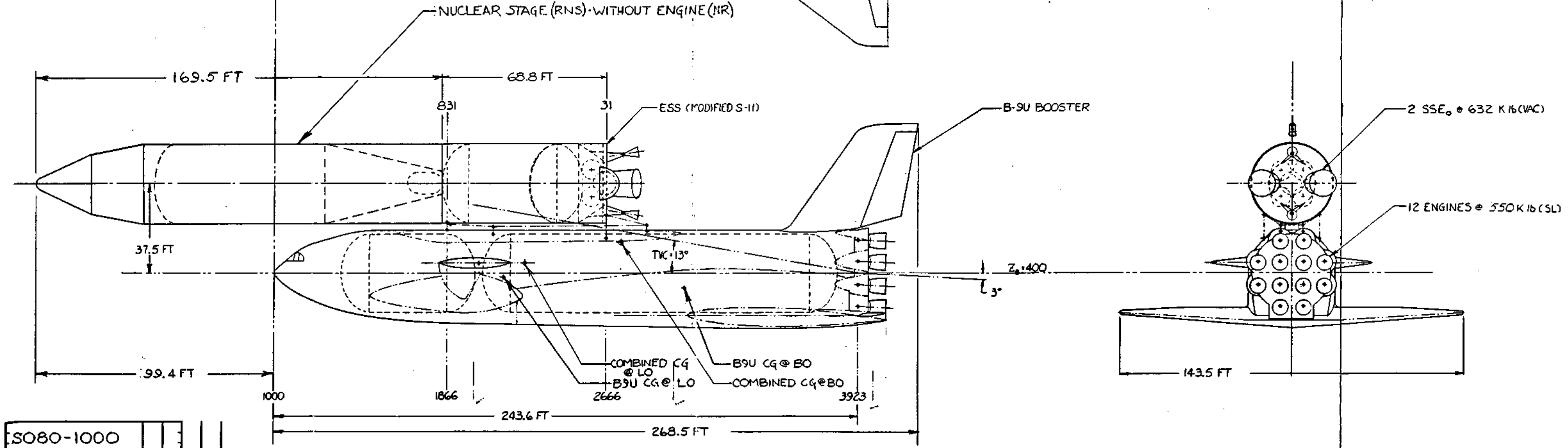
FOLDOUT FRAME 3

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED

CONFIGURATION LIFT-OFF WEIGHTS (lbs)

B-9U BOOSTER	3,570,417
ESS	568,700
PAYLOAD	83,000
TOTAL	4,222,117





DR BY	B. ZEITLER	6-19-73	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 12214 LAKEWOOD BOULEVARD • DOWNEY, CALIFORNIA • 90241
CHK BY			EXPENDABLE SECOND STAGE (ESS)
APPROVED BY			B-9U/ESS/RNS - 3 VIEW MATED CONFIGURATION
			SIZE L · CODE IDENT NO. 03953 · DRAWING NO. S080-0001
			SCALE 1/2 IN. · SHEET

S080-1000

FOLDOUT FRAME 1

FOLDOUT FRAME 2

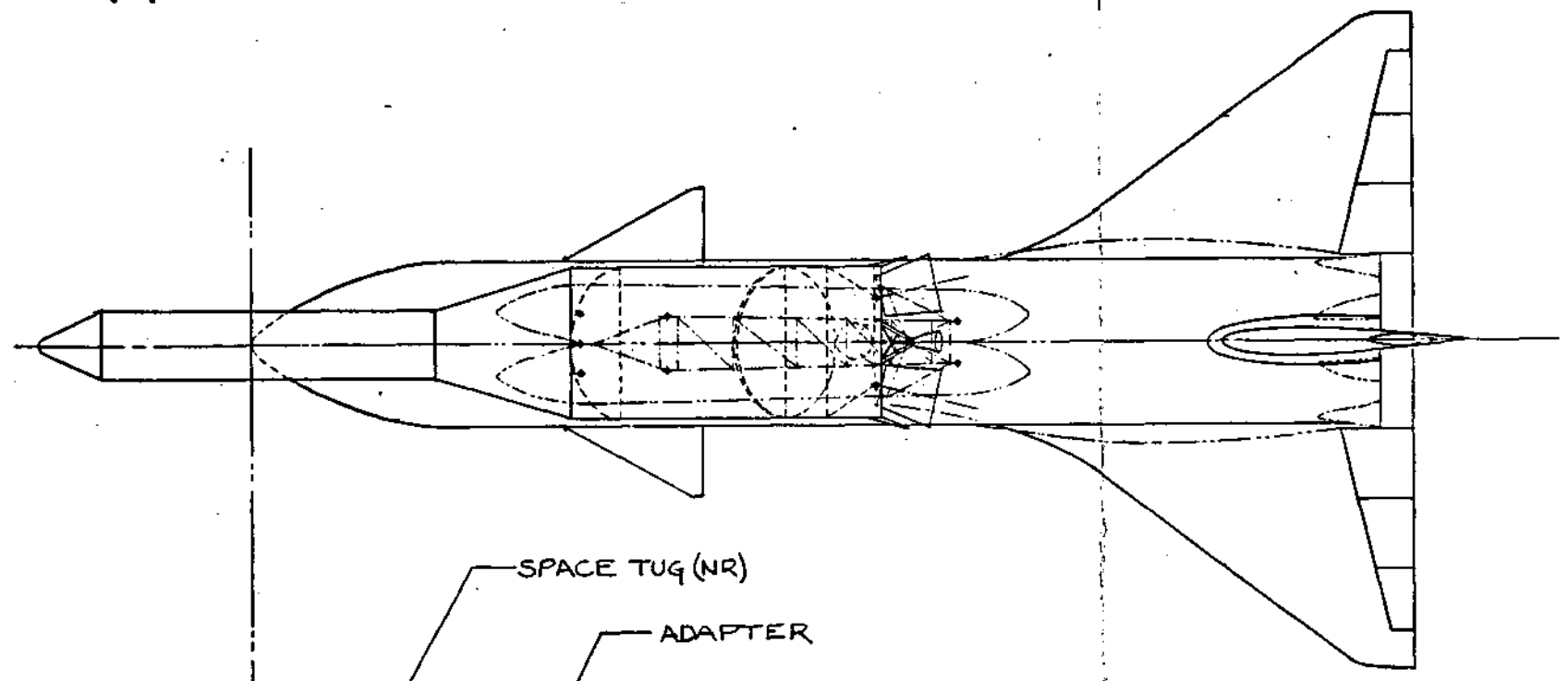
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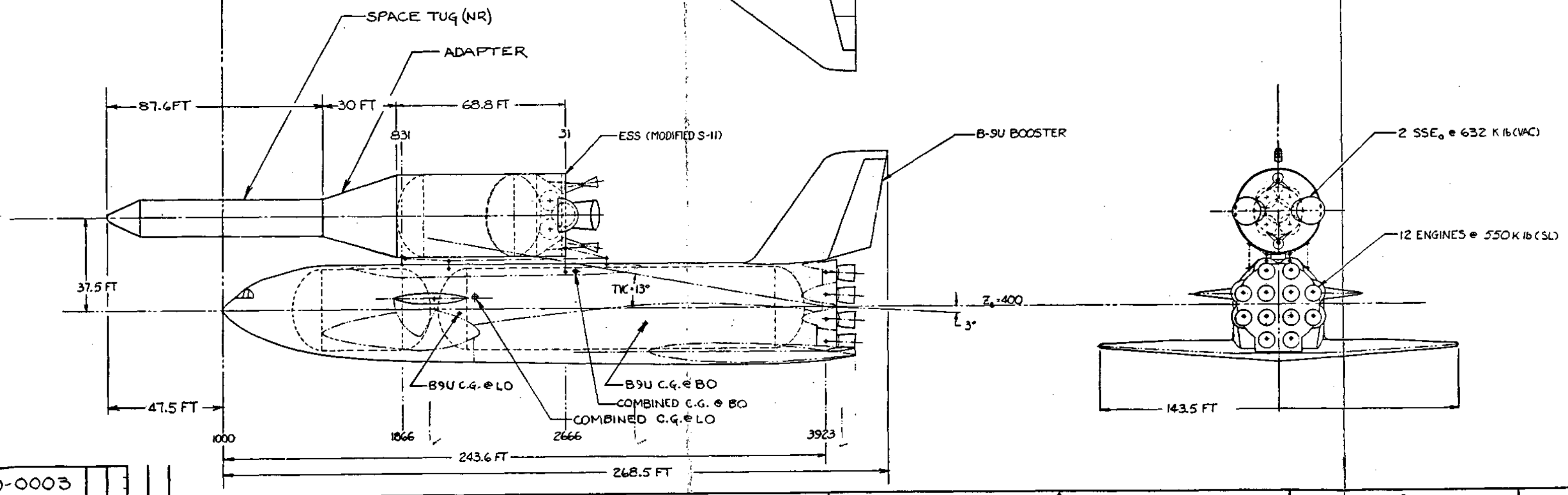
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CONFIGURATION LIFT-OFF WEIGHTS (lbs)

B-9U BOOSTER	3,742,552
ESS	637,705
PAYLOAD	117,180
TOTAL	4,517,437

* INCLUDES ADAPTER



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

SPACE DIVISION
NORTH AMERICAN ROCKWELL CORPORATION

DR BY B. Zeitler
CHK BY
APPROVED BY

EXPENDABLE SECOND STAGE (ESS)
B-9U/ESS/SPACE TUG
MATED CONFIGURATION-3 VIEW

SIZE	CODE IDENT NO.	DRAWING NO.
L	03953	S080-0003

SCALE 1/200 SHEET

S080-0003

FOLDOUT FRAME 1

(2)

FOLDOUT FRAME 2

6-7, 6-8 FOLDOUT FRAME 3